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FUNDAMENTALS OF DESIGNING SHIP REPAIR AND SHIPBUILDING ENTERPRISES

Osnovy proyektirovaniy sudoremontnykh i sudostroitel'nykh predpriyatiy. Moscow. 1955.

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CHAPTER I

TYPES AND INTERVALS OF SHIP REPAIRS

Pages 17-20

SECTION 1. TYPES OF REPAIRS

In order to maintain normal technical condition, repair the physical wear of working parts, and restore the operating capacities of a ship several types of work are done periodically. These types of work can be divided into three groups, depending on their purpose, the intervals between them, and the nature of the technological processes involved.

A. Maintenance Work

This work is performed by the ship's service personnel, without removing the ship from operation. It is intended to maintain the ship in working condition, to reduce to a minimum the physical wear of basic working parts, and consists mainly of dismantling and installation operations.

The organization of this work is based on a planned-compulsory system; i.e., at previously designated intervals, depending on the time during which the machinery operates, it is carefully dismantled and work performed on it according to a previously established set of rules.

The intervals and scope of this maintenance work are quite different for individual machines, depending on the type of machinery, the stress under which it operates, and the speed and other conditions of its operation.

Maintenance work is a part of the technical operation of a ship, and is regulated by the rules for handling and maintenance of the power plant, equipment, and other parts of a ship. This work does not burden the ship-repair enterprises, and does not require the use of machine tools.

B. Repair Work

This work is, as a rule, done by the personnel of the ship-repair enterprise, and the ship is taken out of operation.

The basic purpose of ship repair is to perform a complex of technological processes to restore the ship to working condition.

The organization of ship repair is based on a planned-compulsory system of repair. At previously established intervals a complex of repair operations is performed to provide for the uninterrupted operation of the ship and all its machinery until the established date for the next repair.

The system of planned-compulsory ship repair envisions three categories of repair work, depending on the length of time during which the ship is in operation: capital repairs; medium repairs, coinciding with the periods of technical inspection by the organs of the USSR Registry; and current repairs, or annual repairs, carried out in the minimum scope necessary to provide for uninterrupted operation of the ship during a single voyage.

Reconditioning repairs, which exceed 40 percent of the cost of a metal ship, may be performed only in cases of severe damage, excessive wear to the ship resulting from poor handling and servicing, or delays in maintenance and repair work as established by the Rules for the Planned-Compulsory System of Ship Repair.

Thus reconditioning repairs, which are essentially the result of failure to obey the Rules for the Technical Operation of

Ships, may be performed only as an exception, and may not be taken into account in compiling the long-range plans for the loading of steam-ship-repair enterprises or basins, and must therefore not be included in the computation program which is the basis for designing these enterprises.

C. Modernization Work

This work is usually done during the capital repair of a ship, and is intended to compensate for the "moral" wear of individual mechanisms or design elements of the ship in general. Modernization should improve the operating qualities of the ship in accordance with contemporary technical standards. Individual modernization programs may be carried out in connection with other categories of ship repair using funds for capital investment.

Modernization work includes work on the reequipment of the power plant for different types of fuel, or on the entire ship in connection with changes in its purpose and conditions of operation.

Capital repairs to ships include a large number of modernization programs which are therefore taken into account in the computation program for the loading of enterprises under design.

The computation program for the loading of ship repair shops often includes, as a percentage of planned repairs, in-voyage repairs, consisting of small repairs during voyages to eliminate individual injuries or excessive wear on the ship.

SECTION 2. INTERVALS BETWEEN REPAIRS

On the basis of long experience in the operation of various types of maritime and river ships the intervals between repairs have been established as shown in Tables 1 and 2.

At present, in connection with the completion of the first stage of scientific research work on the wearing of ship machinery and hull structural elements, scientifically based repair intervals should be worked out for the basic ship parts, making it possible to establish a computation program for the design of ship-repair enterprises corresponding more closely to the requirements of fleet operation.

Table 1

Intervals of Planned-Compulsory Repair of River Ships (In Years)

	Repair Category			
	Capital			
Type of Ship	From Construction to First Repair	To Next Repairs	Medium	Current
Steam and Diesel ships: transport, Service-auxiliary, and oil stations	20	16	4	1
Steam-Diesel and suburban-communications ships (with metal hulls)	16	12	4	1
Gas-burning motor ships with metal hulls	16	12	3	1
Self-propelled wooden ships	6	--	2	1
Dredging equipment	12	9	3	1
Non-self-propelled (dry-cargo and tanker) metal ships	20	16	4	1
Gasoline tanker barges	12	9	3	1
Reinforced wooden barges	9	--	3	1
Unreinforced wooden barges	--	--	4	1
Metal earth-removing scows	12	9	3	1
For the rivers of Central Asia and the Kura:				
Self-propelled metal ships	9	9	3	1
Non-self-propelled metal ships	12	9	3	1
Non-self-propelled reinforced wooden channel-going ships	8	--	2	1

Table 2

Intervals of Planned-Compulsory Repair of Maritime Ships (In years)

Type of Ship	Repair Category: Capital — From Construction to First Repair	Capital — To Next Repairs	Medium	Current
Transport ships (steam and Diesel) of the class of the USSR Maritime Registry	12	12	4	1
Transport ships of lower class or none; metal barges	12	9	3	1
Oil tankers	12	9	3	1
Scows and mud dredgers	12	9	3	1
Self-propelled and non-self-propelled earth-removing barges	12	9	3	1
Icebreakers	12	9	3	1
Tugboats and steam cutters	12	9	3	1
Motor cutters	6	6	2	1

Notes: (1) Annual presentation of ships to ship-repair enterprises for current repairs is not obligatory.

(2) One motor cleaning per year, in addition to the above categories of repairs, is planned for Diesel ships sailing in the Caspian and Azov seas.

Table 3

Dry-Docking Intervals (In Months) Depending on the Types of Maritime Ships and Areas in Which They Operate

Basic Ship Groups	Southern Seas and Oceans (Below 50 Degrees Latitude)	Northern Seas and Oceans (Above 50 Degrees Latitude)
Passenger, cargo-passenger, and refrigerator ships	6	12
Other self-propelled and non-self-propelled transport ships of all types	12	24
Icebreakers, similar ships, tugs, and cutters	12	12
Scows and earth-removing barges	24	24
Tugboats	12	24
Wooden ships	12	12

Uncovering the underwater portion of a ship (dry-docking) has been established for metal river ships at intervals coinciding with medium and capital repairs.

Wooden barges, which operate in shallow channels and in locks, can be dry-docked annually depending on their condition.

The dry-dock intervals for maritime ships, depending on type and the region in which they operate, are shown in Table 3.

Dry-docking, with the exception of wooden barges and ocean ships during current repairs, usually coincides with medium and capital repairs, and should be carried out at the expense of the enterprise performing the repair.

CHAPTER II

CLASSIFICATION OF SHIP-REPAIR AND SHIPBUILDING ENTERPRISES

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SECTION 3. CLASSIFICATION OF SHIP-REPAIR ENTERPRISES

Ship-repair enterprises periodically engage in repair work to maintain normal technical condition of ships. A ship-repair enterprise includes a complex of operating units, mooring lines and ship settling tanks, ship-hoisting and other equipment, all with a single administration and a single organizational-technical plan.

Depending on the types of ships repaired these enterprises are divided into maritime and river enterprises, although at the mouths of rivers there are some enterprises which can repair both maritime and river ships.

Ship-repair enterprises are usually classified according to the following factors:

1. The degree of complexity of the basic operation, i.e., the categories of ship repairs;
2. The types of fleet repaired;
3. The region served;
4. The degree of independence of the operational process of the enterprise and the scope of coordinated operations.
5. The volume of nonserial shipbuilding and small-series machine-building (supplementary specialization).

The fleet-repair program loads the ship-repair enterprises unevenly throughout the year; therefore each of them is characterized usually by a supplementary specialization which, depending on the volume of work done, affects the overall production of the enterprise.

During the summer, as a rule, the ship-repair installations prepare spare parts and equipment; this is done by the preparatory and mechanical sections, leaving the hull-and-boiler, woodworking, and installation sections unburdened.

The most widely used operational program for ship-repair installations during various parts of the year consists of the following basic divisions:

1. Current and medium repairs of ships during the winter.
2. Preparation of spare parts and machinery during the summer.
3. Capital repairs of metal ships during the summer.
4. Nonserial shipbuilding organized according to methods adopted in ship-assembly docks, i.e., with contractor deliveries in the volume necessary to load the ship-repair enterprise during the summer with only hull, ship-assembly, and wood work.

It is worthwhile considering the loading of a ship-repair enterprise with the building of those types of ships which are included in the program for capital repairs of this enterprise.

Depending on the equipment of their operating sections ship-repair enterprises are divided into:

1. Ship-repair installations, with a full range of equipped sections in the three basic groups (hull, woodworking, and mechanical), and with mechanical equipment for hoisting ships out of the water and for disassembling them in the water at the enterprise's mooring lines.
2. Ship-repair shops, which do not have mechanical equipment for hoisting ships out of the water and which have well-equipped sections in only one of the three basic groups of the total complex of a ship-repair enterprise.

Table 4

Labor Content of Three Categories of Repair to a 400-Horsepower Twin-Screw Lake Steam Tug L B H [length, breadth, height] = = 37.7 x 7.78 x 3.7 (in man-hours and machine-hours)

Type of Work	Repair	Machine Work	Manual Work	Total Work	Machine Work as a % of Total
General ship preparation	A	--	3,540	3,540	--
	B	--	2,640	2,640	--
	C	--	380[sic]	389[sic]	--
Hull-and-boiler	A	400	11,679	12,079	3.3
	B	200	2,973	3,173	6.3
	C	30	2,506	2,536	1.2
Woodworking, painting, rigging	A	80	4,180	4,260	1.9
	B	20	1,970	1,990	1.0
	C	5	522	527	1.0
Repair of machinery, equipment, fittings	A	4,685	6,325	11,010	43.0
	B	1,410	4,495	5,905	24.0
	C	480	2,710	3,190	13.8
Repair of pipelines and systems	A	390	1,205	1,595	26.0
	B	110	450	560	20.0
	C	40	130	170	23.5
Coppersmithing	A	--	385	385	--
	B	--	365	365	--
	C	--	70	70	--
Repair of electrical equipment	A	40	750	790	5.1
	B	20	425	445	4.5
	C	--	130	130	--
Other	A	270	1,430	1,700	16.0
	B	100	840	940	10.3
	C	25	308	360	14.2
Total for ship	A	5,865	29,494	35,359	--
	B	1,860	14,158	16,018	--
	C	607	6,756	7,363	--

Note on Repairs: A = Capital repairs;
B = Medium repairs;
C = Current repairs.

Depending on the complexity of the operational process in the basic program ship-repair enterprises are divided into:

1. Ship-repair installations whose main mission is capital and medium repairs on metal ships;

2. Ship-repair shops whose principal purpose is current repair of metal ships and all types of repair of wooden non-self-propelled ships, provided in either case only one of the three basic groups of operational sections -- mechanical or woodworking -- is loaded.

The rationale of concentrating capital and medium repairs in installations, and current repairs in shops, can be explained by the following considerations.

Ship repair consists preeminently of laborious operations, with manual work predominating. The proportion of the cost for manpower in the total cost of repair of any given type of ship increases as one proceeds from capital down to current repairs. This is confirmed by Table 4, which shows the distribution of labor content in the repair of a 400-horsepower twin-screw steam tug between mechanical and manual work in the basic sections of the ship-repair enterprise. As the table shows, the proportion of machine work in the total labor performed in the hull section, even in capital repairs, equals only 3-4 percent, and 2 percent in the woodworking section. The proportion of machine work in the total labor of the best-equipped mechanical section is 43 percent for capital repairs, drops to 24 percent for medium repairs, and equals only 14 percent for current repairs. The proportion of all machine work for capital repair equals 19 percent, for medium repair 14 percent, and for current repair 8 percent, of the total volume of work.

Analysis of accounting and estimate calculations gives the following relationship among types of labor in the total cost of operation in various categories of ship repair:

$$\frac{\text{Medium}}{\text{Capital}} = 1.3; \qquad \frac{\text{Current}}{\text{Capital}} = 2.0,$$

i.e., current repairs are the most laborious component of operations since, with small materiel expenses, they require a large volume of manual dismantling, adjustment, and reinstallation work.

Consequently the concentration of current repairs on metal cargo ships in the shops, where overhead expenses are less than in the installations, reduces the cost of this category of repairs and frees the installation-type enterprises of a large number of small and laborious operations, which make more difficult the organization and planning of operations in these enterprises.

On the other hand capital and medium ship repairs in installation-type enterprises load all the basic sections equally, while the somewhat greater overhead expenses in comparison with ship-repair shops are compensated for by reductions in the labor content of these categories of repairs through greater mechanization of work.

Depending on the region served ship-repair enterprises are divided into:

1. Installations serving a number of steamships of an entire basin (Ist-class ship repair installations). Enterprises of a machine-building character, which supply basins with large steel and iron castings, forgings, parts, and machinery, are not included in this classification.

2. Installations serving primarily one steamship (IInd-class ship repair installations).

3. Installation-type enterprises with poorly equipped operating sections (planned to obtain, through cooperation, large and complex parts and complex repaired machinery), serving individual steamship regions or small shipping regions (IIIrd-class ship-repair installations).

Depending on the region served and the presence of simple ship-hoisting equipment the ship-repair shops may be divided into two classes:

1. Ist-class ship-repair shops serving individual large steamship regions or one small shipping region and performing current repairs on the self-propelled fleet. In river transport, shops of this class may also specialize in all categories of repair of wooden barges;

2. IInd-class ship-repair shops, which perform current repairs on small self-propelled and all types of non-self-propelled ships. During the summer these enterprises may reduce their operations. Specialized ship-repair shops specifically assigned to class II are supposed to perform all categories of repairs on small cutters and serve ships on small rivers and suburban lines.

The ship-repair enterprises may also be classified in terms of the type of ships repaired.

In large basins the IInd- and IIIrd-class ship-repair installations usually specialize in the repair of Diesel ships, steamships, scows, cargo-and-passenger ships, and large oil barges.

Ist-class ship-repair shops specialize in current repairs to metal ships and capital and medium repairs to wooden river barges.

Ship-repair installations may be classified also in terms of the degree of independence of the operational process, while only Ist-class ship-repair installations have a sufficient degree of independence since, in performing almost all repairs on the most powerful and complex ships, they receive only the largest forgings, steel castings, and mechanical parts necessary for working on special equipment (the fuel system of engines, etc).

The IInd- and IIIrd-class ship-repair installations, on the basis of coordinated deliveries, receive from specialized enterprises standard ship machinery and parts, and should be fitted with mechanized ship-hoisting equipment and assembly sections.

Depending on the volume and scope of supplementary loading the ship repair installations specialize in:

1. Nonserial construction of the self-propelled fleet (Ist- and IInd-class installations);

2. Small-series construction of metal barges (IInd-class installations);

3. Serial production of small auxiliary machinery and parts for ships.

Broad-scale specialization in the serial production of standard machinery, ship equipment, fittings, and fastening parts makes possible the productive use, during the period between repairs, of available equipment and manpower, raising the technical quality of the production process, and freeing the ship-repair enterprises in the river basin from the production of an enormous number of small ship parts during the winter.

Although the volume of production of a ship-repair enterprise cannot be the basis of its classification, there are nevertheless indexes showing the number of productive workers and the gross production of various types of enterprises.

It should be noted that the concentration of an excessive number of ships for repair by a single enterprise creates considerable difficulties in serving those in the wat .

Tables 5 and 6 give a survey of the indications for classification and the indexes of river and ocean ship repair enterprises. Table 7 presents the average amounts of the basic indexes of river ship-repair enterprises of various classes, based on fulfillment of the optimum program.

In addition to stationary ship-repair enterprises a separate mention must be made of floating ship-repair shops. Their functions are, during the summer, providing floating repairs, cleaning boilers and engines, and doing other prophylactic work performed by the ship commands.

Sometimes special conditions which make it difficult to set up shops on the river bank necessitate performing current repairs to the self-propelled fleet in floating shops even during the winter. In this case these shops receive the minimum complement of equipment of the basic sections of the stationary Ist-class shops.

Floating ship-repair shops are divided into permanent (Ist-class) and those operating only during the summer (IInd-class).

During the winter the floating shops stop in coves and ports which are unequipped with repair resources; there they provide current repairs to metal ships. These shops are usually built on the metal hulls of non-self-propelled ships with one or two superstructure levels. Within the hulls of the two-level shops are storage areas and power equipment. The shops with a single superstructure level have a hand forge and a pipe-repairing and copperworking department in the hull, in addition to power equipment and storage area.

During their voyages the IInd-class floating shops make available all types of power and gas for cutting and welding metal parts for the workers performing prophylactic work on ships during their port stays between voyages and in roadsteads.

SECTION 4. CLASSIFICATION OF SHIPBUILDING ENTERPRISES

Shipbuilding enterprises are divided into river and maritime. They are classified on the basis of indexes showing the degree of complexity of production processes, depending on:

1. The type and equipment of the ships under construction.
2. The material used in the ship hulls.
3. The degree of independence of production.
4. The volume of production.

Two basic groups of shipbuilding enterprises are distinguished: shipbuilding installations and shipbuilding docks. The basic indication separating a shipbuilding installation from a dock is the complexity of production and the degree of completion of the technological process.

An indication of the complexity of a shipbuilding installation is the existence of production and machine-building sections which can perform basic production operations with the principal machines, boilers, auxiliary machinery, special ship fittings, and parts for ship equipment.

A shipbuilding dock is an enterprise which does not have these sections, and which receives from specialized machine-building installations, through coordination, the principal motors and auxiliary machinery, radios and electrical equipment, standard fittings, and large castings and forgings for the hull. A shipbuilding dock prepares nonstandard ship parts, equipment, and systems, builds the ship, and installs all the equipment received.

Depending on the type of material from which the hull is made, steel and wood shipbuilding installations and docks are distinguished.

Depending on the type of ships being built shipbuilding enterprises are identified as building (1) Self-propelled ships; (2) Metal barges; (3) Wooden barges; (4) Reinforced-concrete barges and support ships.

Table 5

Classification of Features of River Ship-Repair Enterprises

Ist-Class Installations:

Region of Operation: River basins.

Basic Production Activity: Capital and medium repairs to self-propelled ships and scows; shipbuilding and machine-building no less than 60 percent of total.

Supplementary Burdens: Assembly and installation of self-propelled ships and scows of unique construction. Serial production of ship machinery weighing up to 5 tons. Production of large and spare parts.

Capacity of Production Sections: Foundry sections with smelting equipment up to 2 tons and forge hammers up to 2 tons.

Ship-Hoisting Equipment: Ship-hoisting slip.

Total Annual Production: Over 17 million rubles.

Average Number of Workers: Over 600.

IInd-Class Installations

Region of Operation: Steamships.

Basic Production Activity: Capital and medium repairs of self-propelled ships, metal barges, and scows; shipbuilding and machine-building no less than 40 percent of total.

Supplementary Burdens: Assembly and installation of self-propelled ships of unique design up to 400 horsepower. Small-serial construction of metal barges. Serial production of ship machinery weighing up to 2 tons, production of spare parts weighing up to 0.5 ton.

Capacity of Production Sections: Smelting equipment in foundry section up to one ton, forge hammers up to one ton.

Ship-Hoisting Equipment: Ship-hoisting slip.

Total Annual Production: 9.0-15 million rubles.

Average Number of Workers: 400-600.

IIIrd-Class Installations

Region of Operation: Steamships.

Basic Production Activity: Capital and medium repairs to steamships, current repairs to freight-passenger ships and scows; capital and medium repairs to metal barges not less than 40 percent of total.

Supplementary Burdens: Small-serial construction of metal barges; serial production of parts for ship equipment and ship fittings.

Capacity of Production Sections: Manual forge; bronze foundry casting up to 300 kilograms.

Type of Ship-Hoisting Equipment: Simple type of ship-hoisting dock.

Total Annual Production: 5.0-8.5 million rubles.

Average Number of Workers: 200-400.

Ist-Class Shops

Region of Operation: Steamships.

Basic Production Activity: Current repairs on large self-propelled ships; medium repairs on metal ships without drydocking; medium repairs to wooden barges; in-voyage repairs to self-propelled ships.

Supplementary Burdens: Nonserial construction of landings; fire watch (on wooden ships).

Capacity of Production Sections:Manual forge; bronze foundry casting up to 100 kilograms.

Ship-Hoisting Equipment: Slideways, or floating wooden dock.

Total Annual Production: 2.5-5.0 million rubles.

Average Number of Workers: 100-240.

IInd-Class Shops

Region of Operation: Ports and harbors.

Basic Production Activity: Current repairs to local self-propelled fleet and non-self-propelled transport fleet; in-voyage repairs to local fleet.

Supplementary Burdens, Capacity of Production Sections, Ship-Hoisting Equipment: None.

Total Annual Production: Up to 2.0 million rubles.

Average Number of Workers: Up to 100.

Table 6

Classification of Features of Maritime Ship-Repair Enterprises

Ist-Class Installations

Region of Operation: Inter-basin service to the maritime transport fleet.

Basic Production Activity: Capital and medium repairs to international and long-range maritime coasting ships not less than 50 percent of total. Boiler repairs.

Supplementary Burdens: Assembly and installation of large maritime ships of unique design; serial production and repair of large and complex ship machinery. Production of large parts and spares for them.

Equipped Production Sections: Large foundry section for all types of casting. Heavy hammers and presses in forge section.

Ship-Hoisting Equipment: Drydock or slip. Floating dock for individual large ships.

Total Annual Production: Over 40 million rubles.

Average Number of Workers during Year: Over 1,500.

IInd-Class Installations

Region of Operation: Ocean basins.

Basic Production Activity: Capital and medium repairs of small coasting ships and technical fleet, no less than 40 percent of total. Boiler repair.

Supplementary Burdens: Assembly and installation of small self-propelled ships. Serial production and repair of medium-sized and small ship machinery. Production of spare parts for basin shops.

Equipped Production Sections: Iron-and-copper foundry; forge with light hammers.

Ship-Hoisting Equipment: Slip and floating dock.

Total Annual Production: 17-40 million rubles.

Average Number of Workers during Year: 500-1,500.

IIIrd-Class Installations

Region of Operation: Large ocean ports and ports of registration.

Basic Production Activity: Current repairs to large-tonnage international and long-range coasting fleet. Capital and medium repairs to port, technical, and service-auxiliary fleet.

Supplementary Burdens: Nonserial construction of metal barges; installation on ships of machinery repaired in other installations; production of fittings.

Equipped Production Sections: Iron foundry and forge of limited capacity.

Ship-Hoisting Equipment: Floating dock and elongated slip for port fleet.

Total Annual Production: 8-15 million rubles.

Average Number of Workers during Year: 300-600.

Ist-Class Shops

Region of Operation: Ocean ports.

Basic Production Activity: Current repairs of self-propelled fleet; capital and medium repairs of non-self-propelled fleet.

Supplementary Burdens: Installation on ships of machinery repaired in other installations.

Equipped Production Sections: Small bronze foundry; manual force.

Ship-Hoisting Equipment: Floating dock; slideway for non-self-propelled fleet.

Total Annual Production: 3.5-8.0 million rubles.

Average Number of Workers during Year: 150-300.

IInd-Class Shops

Region of Operation: Port of registration.

Basic Production Activity: Current repairs of port fleet.

Supplementary Burdens, Equipped Production Sections, Ship-Hoisting Equipment: None.

Total Annual Production: 1.5-3.5 million bubles.

Average Number of Workers during Year: Less than 150.

Floating Shops

Region of Operation: Large ocean ports.

Basic Production Activity: In-voyage repairs to large ocean ships.

Supplementary Burdens, Ship-Hoisting Equipment: None.

Equipped Production Sections: Bronze foundry and manual forge.

Total Annual Producton: Up to 2 million rubles.

Table 7

Basic Indexes of Ship-Repair Enterprises for the River Fleet (Average Data)

[1] Indexes	[2] Installations (Class) Ist	[3] IInd	[4] IIIrd	[5] Ist-Class Shops Repairing Ships of Metal	[6] Wood	[7] IInd-Class Shops
Land area, in hectares	14	9	7	3	4	1.5
Water area, in hectares	15	5	20	14	16	10
Length of mooring-line equipment ("pog." [unidentified] meters)	250	150	100	--	--	--
Mechanized ship-hoisting equipment	Slip	Slip	Slip	Floating dock	Slideway	--
Number of dockyard points	12	8	6	1	4	4
Foundry sections:						
Annual casting (tons)	700	400	250	--	--	--
Maximum weight of castings (tons)	3	1	1	--	--	--
Forge section, maximum hammer tonnage	2	1	0.5	0.3	0.3	0.3
Mechanical section, average number of metal machine tools	60	35	20	15	7	10
Hull-and-boiler section, steel processed annually (tons)	1,200	600	300	80	--	45
Woodworking section, quantity of lumber processed annually (1,000 cubic meters)	8	4	2.5	1.5	6	1.5
Maximum lift capacity of crane equipment (tons)						
In the slip	6	6	6	--	--	--
On mooring lines	15	10	10	1.5	--	1.0

[continued]

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[Table 7, continued]

[1]	[2]	[3]	[4]	[5]	[6]	[7]
Average capacity of compressor stations (cubic meters per minute)	40	20	16	10	16	10
Number of laboratory divisions	8	6	4	--	--	2
Power available per registered worker, in kilowatts	2.2	1.8	1.4	1.0	1.2	1.2
Number of ships repaired	50	60	90	100	100	60
Capital repairs	25	20	10	--	20	15
Average repairs	25	40	30	--	30	15
Total average production (million rubles)	20	12	7	410	--	2.0
Shipbuilding and machinebuilding in proportion to total work	30	15	10	--	--	--
Average number of registered workers	800	500	300	200	--	80

The shipbuilding docks which specialize in building non-self-propelled ships are characterized by a large material content of their product in contrast to those shipbuilding installations and docks which build self-propelled ships.

Depending on the degree of independence the shipbuilding enterprises are divided into:

1. Ist-class shipbuilding installations which produce steam boilers, principal and auxiliary machinery, and steel castings for ships.

2. IInd-class shipbuilding installations which do not have large production sections, but which obtain their principal machinery and boilers from elsewhere, and build only auxiliary machinery and parts for ship equipment.

3. Ist-class shipbuilding docks which produce individual, nonstandard auxiliary machines, parts for ship equipment, and receive from specialized machine-building installations all other equipment for self-propelled ships.

4. IInd-class shipbuilding docks which produce only ship hulls, and install all machinery and ship equipment received from specialized machine-building enterprises.

5. IIIrd-class shipbuilding docks which assemble ships from shaped and flat hull sections received from other enterprises. The production process in these enterprises includes the dockyard assembly of ship hulls, installation of equipment obtained from elsewhere, and the delivery of complete ships.

On the basis of these characteristics the following classification has been adopted for shipbuilding docks (Table 8), with the basic indexes calculated for shipbuilding enterprises which build river boats.

Table 8

Average Indexes of Shipbuilding Docks

Indexes	Classes of Shipbuilding Docks Ist	IInd	IIIrd
Total annual production (million rubles)			
Self-propelled ships	70	30	9
Non-self-propelled metal ships	25	15	7
Non-self-propelled wooden ships	18	12	5
Number of ships produced annually (1,000 tons)			
Self-propelled ships	30	15	8
Non-self-propelled metal ships	50	30	12
Non-self-propelled wooden ships	40	20	10

In capitalist countries the independence of shipbuilding enterprises requiring large quantities of metal sometimes goes so far as the creation of combines including metallurgical plants and steel foundries. As a result the production process in such an enterprise begins with heating the raw material (ore) and ends with delivery of the finished ship.

Under the socialist economy of the Soviet Union there is no point in creating such enormous enterprises with such varied products, since their administration is complicated and the problems of supplying metal to them are solved by the single planning organ of the Soviet state.

In changing over to serial shipbuilding the construction of standard machinery, equipment, and fittings for ships by specialized Soviet enterprises presents no difficulties and contributes to raising the quality and lowering the cost of production.

Existing shipbuilding enterprises cannot always be strictly limited by the classification scheme presented. In the range from docks which merely assemble to independent shipbuilding installaations one encounters mixed enterprises. For example individual docks which receive their principal machinery from other producers also have their own large forges and foundries.

Determining the classes of enterprises depends on the type of ship being built, and whether production is serial; on location and transport facilities; and on the productive capacities of the machine-building enterprises in the vicinity.

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SECTION 20. SIZES OF ENTERPRISES Pages 70-72

For the preliminary determination of the sizes of enterprises we used reinforced indexes established on the basis of experience in building analogous enterprises.

Shipbuilding installations, as independent enterprises having mechanical sections with a large number of workers and frequently placed in awkward positions, have the best indexes of the number of workers per hectare of land area -- from 200 to 350 persons.

The normal density of workers on the territory of shipbuilding docks which are built according to plan, in harmony with the technological process, and with the proper degree of mechanization of production (with covered dockyards and preliminary assembly sections, and large warehouses and auxiliary areas) is 110-140 persons per hectare.

Table 11 presents data on the density per hectare of parts of active shipbuilding enterprises when fully loaded.

Table 11

Number of Workers and Service Personnel per Hectare of Area in Shipbuilding and Ship-Repair Enterprises (Based on Data from Active Enterprises)

Enterprise [1]	No of Workers [2]	Area (Ha) [3]	Workers per Ha [4]	Mechanical Section Group [5]
Maritime shipbuilding installation	2,600	7.0	371	Yes
Large maritime shipbuilding installation	6,800	22.5	300	Yes
Maritime shipbuilding dock	18,000	77.0	234	No
The same	3,800	18.1	210	No
The same	4,880	25.0	195	No
Large maritime shipbuilding dock	35,000	343.0	101	No

[continued]

[Table 11, continued]

[1]	[2]	[3]	[4]	[5]
Maritime ship-repair installation	5,000	15.2	309	Yes
Ship-repair installation with floating and dry docks	1,300	8.7	150	No
Maritime ship-repair installation	1,590	25.2	64	--
River shipbuilding dock (planned)	4,000	40.0	100	No
River ship-repair-and-building installation (planned)	2,140	24.0	90	--
River ship-repair installation	1,480	11.1	132	--
The same	760	6.8	112	--
The same	762	12.8	60	--
The same	2,684	25.0	115	--

From the gross indexes one must determine the total number of production workers in the enterprise and the number employed. Then on the basis of data on the dimensions of docked ships one calculates the number of dockyard places in the slip or drydock and the area of the ship-raising equipment.

The area of territory occupied may be obtained by adding up the total built-up area and the area occupied by ship-raising equipment and multiplying the sum by the coefficient 1.12, taking into account the area necessary for open-air operations and warehouse space.

The area devoted to roads and engineering communications is not included here.

In this manner the total area occupied is determined by the formula:

$$A = (PK_1 + C) \times 1.12 \qquad (7)$$

where P = the number of production workers;

K_1 = the built-up area per production worker, expressed in square meters; in a well-equipped ship-repair installation K_1 will equal 14/20 square meter, while for shipbuilding docks K_1 = 26/35 square meter. The docks engaged in serial construction of ships have a larger value for K_1 (docks building ships in covered dockyards, with preassembly of flat, shaped, and complex sections).

C = the area occupied by ship-hoisting equipment, in square meters.

Thus the total territory of the installation is:

$$T = \frac{A}{K_2} \qquad (8)$$

where K_2 is the coefficient of built-up territory; for river and maritime ship-repair enterprises K_2 = 0.35/0.50; for river and maritime shipbuilding docks the coefficient of built-up territory K_2 = 0.40/0.60.

Table 12 presents data on the density of construction in shipbuilding and ship-repair enterprises.

Table 12

Density of Construction Area in Shipbuilding and Ship-Repair Enterprises

Enterprise	Area (Ha)	Area Occupied (Ha)	Coefficient of Built-Up Territory
Maritime shipbuilding installation	29.6	15.4	0.52
Maritime shipbuilding-ship-repair installation	26.6	12.0	0.45
Maritime shipbuilding dock	18.1	6.2	0.34
River shipbuilding and ship-repair installation	24.0	6.7	0.28
River ship-repair installation (planned)	12.8	5.8	0.44

The data given in Table 12, which were established on the basis of analysis of the density of built-up area in active shipbuilding and ship-repair enterprises and some planned installations, are, naturally, average. The use of these data, however, for the purposes outlined above, is quite permissible.

CHAPTER VIII

METHODS OF CALCULATION

SECTION 21. CLASSIFICATION OF CALCULATION METHODS Pages 75-92

Existing methods of calculating the loading of a ship-repair and shipbuilding enterprises may be classified as follows:

1. Based on technological processes of building or repairing ships according to a precise program.

2. Based on standard technological processes of computation (standard) ships in the above program.

3. According to technical indexes:

   (a) Of labor content;

   (b) Of material content.

4. Based on economic indexes.

5. Statistical methods.

The methods of organizing production, the processing of parts, and, of course, planning of equipment in sections and the calculation of their loading have their characteristic features, depending on the type of production.

In one and the same enterprise or section one may encounter different types of production. In individual production, which ship repair is basically, the production of small and frequently-used parts of ship machinery or hull equipment may be organized according to the principle of serial production. This refers primarily to fittings, fasteners, illuminating devices of standard type and dimensions, and the outer packing for refrigerators, the replacement of which even in one ship frequently requires production in large quantities.

SECTION 22. METHOD OF CALCULATING LOADING BY TECHNOLOGICAL CHARTS FOR SHIPS ACCORDING TO A PRECISE PROGRAM

In designing an industrial enterprise the most accurate method is that of calculating loading of individual sections by technological charts worked out for all parts which will be produced by the enterprise, and are to be used in repairing or building a ship. For this purpose one must have a detailed inventory, sketches, specifications, and technical specifications for all the ship parts produced.

The production program established for each section makes it possible, with the scheme adopted for production organization, to obtain the fullest and most precise data on the necessary number of workers by specialties and skills, the number and types of all structures, and the dimensions of all productive and auxiliary buildings and structures in the enterprise being designed.

Designing an enterprise according to a precise program with a detailed development of technological charts for each part requires the participation of a large number of design specialists in each type of work and considerable time and funds for the design work.

The operational technological chart (Supplement 1) gives a picture of the sequence of establishing the technology of mechanical processing. Supplement 2 presents a digest chart of the processing of a part on machine tools; instead of individual detailed charts by transfer operations this supplement gives a list of all work, by operations, necessary to process a piston ring, showing the method of processing, the necessary tool, and the time norm for each operation.

Supplement 3 illustrates the method of compiling technological charts for foundry work (the casting of a cylinder liner for an engine).

Working up these charts to determine the loading of sections can be justified only for the production of large series of relatively simple parts with a small number of details.

In designing shipbuilding enterprises, and even more ship-repair enterprises, the compilation of such laborious technical documents is not desirable. This becomes clear when we realize that a ship consists of numerous parts combined in a complex whole and that these parts differ greatly from one another both in design and in material, and therefore both in terms of the technological processes of their manufacture and in the assembly of their various parts.

In addition, the calculation program adopted for the design of shipbuilding enterprises is, in the majority of cases, a conditional one, making it possible to determine only the character and scope of production and the limiting dimensions and weight of the ships which it is planned to build.

Ordinarily after several years of operation of a shipbuilding enterprise according to the given calculation program it becomes necessary to build different ships in this enterprise, ships with better operating indexes in comparison with former types, or intended for operation in other areas or to carry different cargoes.

Concerning a ship-repair enterprise even if, carefully assigning ships to registered enterprises for repair, it is possible to load the enterprise in the first years in accordance with the precise calculation program established, the volume and variety of repair work on individual ships will differ considerably from that established in the design, depending on the level of technical servicing and the quality of handling. Naturally the enormous and expensive technical documentation on the basis of which the enterprise design was worked out will not be used.

In serial shipbuilding the designing of the technological process according to a precise program can be simplified such that technological charts can be worked out only for the most characteristic and complex details of each ship part and group of parts. For other small parts it is usually possible to stop collecting information with a survey of the basic operations in processing them. For each group of structural parts of the calculation ship the information on part details is compiled according to the following form, entitled

"Parts Information for the Calculation Program on .... Ship."

Number

Name of Part

Number of Part

Number of Drawing

Materials

Name and GOST

Castings and Forgings (of above)

Number of Parts in Mechanism or Structural Unit

Total Parts in Annual Program

Weight of Parts (Kilograms)

Black [Ferrous?]

Net [Clean?]

Share in Annual Program of Spare Parts (Kilograms)

Black [Ferrous?]

Net [Clean?]

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SECTION 23. METHOD OF CALCULATING LOADING IN TERMS OF STANDARD TECHNOLOGICAL PROCESSES FOR SHIPS IN THE ABOVE PROGRAM

The most precise result in designing ship-repair enterprises can be achieved from using the method of calculation according to standard repair information.

From a study of the nature and scope of wear on the basic working parts of ship machinery and hulls the standard types of work operations can be established for capital and medium repairs.

Standard technological information by individual structural units of hull and machinery for three categories of repair are worked out according to the established system.

Supplement 4 presents standard information on the capital repair of an inclined ship steam engine according to the planned-compulsory system.

Standard repair information gives the necessary data for calculating the loading of equipment and the necessary manpower for the sections of a ship-repair enterprise. At the same time excerpts from this information may determine the number and weight of castings and forgings necessary to repair the structural units of a ship as well as the basic materials. Instead of working technological charts for the entire range of parts of a precise calculation program, the repair technological information is compiled for only standard (representative) ships.

In this case all the ships in the calculation program are divided into groups. Each group includes the ships which are closest to one another in design, hull dimensions, and power of the principal machinery. The technological processes of repairing ships in each group differ only slightly from one another, and the results of calculating the labor content of repair work by basic structural units of the representative ship are extended to all ships in the group.

Designing a ship-repair enterprise according to this method makes possible the use, from previously worked out designs and material, of the indexes of labor required in the construction of ships of similar types with production organized according to a similar system. In this manner, instead of compiling in detail the technological process of building ships according to a precise program, practical or calculated technological processes are used to build ships more or less analogous with respect to type and dimensions.

SECTION 24. CALCULATION OF LOADING ACCORDING TO TECHNICAL INDEXES

The loading of an installation in terms of technical indexes can usually be calculated only for the first stage of design, i.e., for the project assignment. For the technical design this method gives insufficiently accurate results.

Technical indexes of labor or material content are established on the basis of analysis of the operation of existing ship-repair or shipbuilding enterprises with an approximately similar program, or on the basis of previously worked out designs for such enterprises.

Indexes of the labor content of ship repair, as obtained from data of previously compiled designs or from generalizing the results of calculating expenses, manpower (labor content), or materials (material content), determine the dependence of each ship-repair category in the above calculation program on parameters characterizing the type and scope of work to repair each ship.

Standard information is compiled for each repair category of individual standard ship machinery -- main and auxiliary -- and also by ship facilities and systems, hulls, and the number in the hulls for standard ships and hulls.

In order to determine indexes of labor content of any repair category, a list is made of all the elements (machinery and facilities) for the standard ship and, adding up the data on labor content and material content of individual elements, one obtains labor or material content separately for repairs to mechanical equipment and hull elements.

Figure 11 presents a graph of the total labor content of capital repairs to various types of ships. The right-hand diagram (mechanical and preparatory sections) shows labor content as a function of the capacity of power equipment. The left-hand diagram (hull sections) shows labor content as a function of the basic linear measurements of ship hulls of each type (LBH). The labor content of repair on non-self-propelled ships for the mechanical sections as a function of LBH is shown by dotted line. This system is usually used in order to establish the scope of repairs to various types of ships. An analogous graph for medium repairs to river ships is given in Figure 12, where the symbols are the same as in Figure 11.

Data for medium and capital repair of maritime ships of various types are given in Figures 13 and 14 respectively, with analogous symbols used in both figures.

These relationships can be established for each worker specialty (for each production section) and for the entire ship-repair enterprise as a whole.

The labor content for each section in the latter case is established by breaking down the total labor content (in percent) by production sections, separately for mechanical and hull sections.

Tables 13, 14, 15, 16, and 17 give a breakdown of total labor content of repairs to basic types of river and maritime ships by production sections in the hull, mechanical and preparatory groups of a ship-repair installation for various categories of repair.

Table 13

Breakdown of Total Labor Content of Capital and Medium Repairs to Ships of the River Fleet, for the Hull Sections (In Percent)

Ship Type [1]	Hull Sections: In Shop [2]	Hull Sections: In Slip or Dock [3]	Hull Sections: In Water [4]	Hull Sections: Total [5]	Wood-working [6]	Paint-ing [7]	Rig-ging [8]	Sail-making [9]	Total [10]
Capital Repair									
Tugs	7.0	38.5	14.0	59.5	33.5	5.8	1.0	0.2	100
Cargo-passenger steamships	4.5	28.5	11.0	44.0	44.0	9.5	1.0	1.5	100
Dry-cargo barges	[illegible]	51.0	26.0	85.0	9.8	4.0	1.0	0.2	100
Oil-tank barges	14.5	52.5	26.35	93.35	3.0	2.5	1.0	0.15	100
Scows	7.0	35.5	25.0	67.5	15.0	9.0	7.5	1.0	100
Dry-cargo wooden barges	--	--	--	--	83.0	13.5	3.0	0.5	100
Medium Repair									
Tugs	5.0	42.5	10.0	57.5	29.0	11.0	2.0	0.5	100
Cargo-passenger steamships	2.5	20.5	5.0	28.0	60.0	9.5	1.5	1.0	100
Dry-cargo barges	5.5	55.0	24.0	84.5	9.0	[illegible]	1.5	0.5	100

[continued]

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[Table 13, continued]

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Oil-tank barges	13.0	55.5	21.3	92.8	3.0	4.5	1.5	0.2	100
Scows	4.5	35.0	17.0	56.5	14.0	15.0	13.0	1.5	100
Dry-cargo wooden barges	--	--	--	--	83.5	13.5	2.5	0.5	100

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Table 14

Breakdown of Total Labor Content of Capital Repairs to Ships of the River Fleet, for the Mechanical and Preparatory Sections (IN Percent)

Ship Type [1]	Power, Capacity, Displacement [2]	Machine-Assembly Work: Mechanical [3]	Machine-Assembly Work: Manual [4]	Repair and Installation: Machinery [5]	Repair and Installation: Pipelines [6]	Welding [7]	Copper- and Tin-smithy [8]	Electrical Repair [9]	Forging [10]	Casting [11]	Total [12]
Freight-passenger steamships	300 HP	25.0	20.0	[illegible]	[illegible]	4.0	2.5	[illegible]	3.0	2.5	100
The same	600 HP	25.5	20.0	[illegible]	[illegible]	4.0	2.5	[illegible]	4.5	3.0	100
The same	1,200 HP	25.0	18.0	[illegible]	11.5	3.5	2.5	14.5	7.0	3.0	100
Steam tugs	300 HP	25.5	25.0	18.5	8.5	5.5	2.0	[illegible]	3.0	3.0	100
The same	600 HP	26.5	23.0	[illegible]	8.5	4.5	2.0	5.0	5.5	3.0	100
The same	1,200 HP	27.0	[illegible]	[illegible]	[illegible]	4.0	2.0	8.0	8.0	4.0	100
Freight-passenger Diesel ships (screw type)	300 HP	21.0	15.5	[illegible]	[illegible]	3.5	2.5	31.5	1.5	2.5	100
The same	600 HP	21.5	16.0	[illegible]	[illegible]	3.0	2.5	31.5	2.0	3.0	100
The same	1,200 HP	21.5	16.0	13.5	[illegible]	3.0	2.5	26.0	2.5	4.0	100
Diesel tugs (paddle-wheel type)	300 HP	22.5	21.0	14.5	[illegible]	3.5	2.0	25.0	3.5	2.5	100
The same	600 HP	22.5	20.5	15.0	7.0	3.0	2.0	22.5	5.0	2.5	100
The same	1,200 HP	25.0	17.0	[illegible]	7.5	3.0	2.0	18.	7.0	3.5	100

[continued]

[Table 14, continued]

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Dredgers	100 m³, 180 HP	24.5	24.5	15.0	9.5	11.0	1.5	6.5	1.0	6.5	100
The same	250 m³, 500 HP	24.0	23.5	15.5	9.5	11.0	1.5	6.5	1.0	7.0	100
The same	500 m³, 1,000 HP	22.5	21.5	16.5	9.5	13.5	1.5	5.5	2.0	7.5	100
Earth-pumping scows	100 m³, 180 HP	24.0	24.0	16.0	11.5	10.5	1.5	7.0	1.0	4.5	100
The same	250 m³, 500 HP	23.0	23.0	16.5	11.5	10.5	1.5	7.0	1.0	6.0	100
The same	500 m³, 1,000 HP	22.5	21.5	16.5	12.0	11.5	1.5	6.5	1.5	6.5	100
Motor cutters	25 HP	24.5	27.5	11.0	8.0	5.5	2.0	13.5	3.0	5.0	100
The same	50 HP	24.5	27.0	10.5	9.5	4.5	2.0	13.5	2.5	6.0	100
The same	100 HP	27.0	27.0	11.5	10.0	3.5	2.0	10.5	2.0	6.5	100
Dry-cargo iron barges	200 tons	18.5	15.5	23.5	--	2.5	21.5	--	15.0	3.5	100
The same	1,000 tons	19.5	15.5	24.0	--	2.5	20.5	--	13.5	4.5	100
The same	3,000 tons	19.5	16.5	25.0	--	2.5	18.5	--	13.5	4.5	100
Dry-cargo wooden barges	500 tons	19.0	16.0	6.5	--	3.0	38.0	--	12.0	5.5	100
Oil-tank barges	3,750 tons	19.0	10.0	25.0	23.0	7.0	1.5	--	11.0	3.5	100
The same	6,000 tons	21.0	14.0	22.0	20.5	7.0	1.5	--	10.0	4.0	100
The same	12,000 tons	21.0	14.0	22.0	20.5	7.0	1.5	--	10.0	4.0	100

Table 15

Breakdown of Total Labor Content of Capital Repairs to Ships of the River Fleet, for the Mechanical and Preparatory Sections
(In Percent)

Ship Type [1]	Power, Capacity, Displacement [2]	Machine-Assembly Work: Mechanical [3]	Machine-Assembly Work: Manual [4]	Repair and Installation: Machinery [5]	Repair and Installation: Pipelines [6]	Welding [7]	Copper- and Tinsmithy [8]	Electrical Repair [9]	Forging [10]	Casting [11]	Total [12]
Freight-passenger steamships	300 HP	15.5	37.0	21.0	9.0	3.0	2.5	9.0	1.5	1.5	100
The same	600 HP	16.5	35.5	22.5	9.5	2.5	2.5	8.0	1.5	2.0	100
The same	1,200 HP	17.5	32.0	22.5	10.0	2.0	3.5	7.5	2.5	2.5	100
Steam tugs	300 HP	17.0	41.0	23.0	6.0	3.0	2.5	4.5	1.0	2.0	100
The same	600 HP	18.0	39.5	23.5	6.0	2.5	2.5	4.5	1.5	2.0	100
The same	1,200 HP	20.0	35.0	24.5	6.5	2.0	2.5	4.0	2.5	3.0	100
Freight-passenger Diesel ships (screw type)	300 HP	14.0	31.0	16.5	7.5	2.0	2.0	23.5	1.5	2.0	100
The same	600 HP	14.5	30.0	16.5	7.5	1.5	2.0	23.0	1.5	3.5	100
The same	1,200 HP	17.0	29.5	19.0	8.5	1.0	3.0	17.0	1.0	4.0	100
Diesel tugs (paddle-wheel type)	300 HP	16.0	34.0	20.0	4.5	2.0	2.0	17.5	2.0	2.0	100
The same	600 HP	16.5	33.0	21.5	4.5	1.5	2.0	15.0	2.0	2.0	100
The same	1,200 HP	20.5	30.0	23.5	5.0	1.5	2.0	12.5	2.0	3.0	100

[continued]

[Table 15, continued]

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Dredgers	100 m^3, 180 HP	16.5	38.5	19.5	7.0	7.5	1.5	2.5	0.5	6.5	100
The same	250 m^3, 500 HP	15.0	37.5	19.5	7.0	7.5	1.5	3.5	1.0	7.5	100
The same	500 m^3, 1,000 HP	15.0	33.0	22.5	8.0	7.5	1.5	3.5	1.0	8.0	100
Earth-pumping scows	100 m^3, 180 HP	15.5	39.5	22.0	6.5	6.0	1.0	3.5	0.5	5.5	100
The same	250 m^3, 500 HP	15.0	35.0	22.0	8.5	6.0	1.5	4.5	1.0	6.5	100
The same	500 m^3, 1,000 HP	14.5	32.0	24.0	9.5	6.0	1.5	4.5	1.0	7.0	100
Motor cutters	25 HP	21.0	36.5	16.5	8.0	3.5	1.5	8.0	2.5	2.5	100
The same	50 HP	21.0	37.0	16.0	9.0	3.5	1.5	7.0	2.5	2.5	100
The same	100 HP	22.5	38.5	15.5	9.0	2.5	1.5	6.0	2.0	2.5	100
Dry-cargo iron barges	200 tons	13.0	16.5	32.5	--	2.5	31.0	--	3.0	1.5	100
The same	1,000 tons	13.5	16.5	38.5	--	2.0	24.5	--	3.0	2.0	100
The same	3,000 tons	15.0	17.0	39.0	--	2.0	21.5	--	3.5	2.0	100
Dry-cargo wooden barges	500 tons	15.0	7.5	15.0	--	3.0	45.0	--	11.5	3.0	100
Oil-tank barges	3,750 tons	13.0	18.0	30.5	21.5	7.0	1.5	--	6.5	2.0	100
The same	6,000 tons	14.5	18.5	30.5	18.5	7.5	1.5	--	7.0	2.0	100
The same	12,000 tons	14.5	19.0	30.5	17.0	7.5	1.5	--	7.0	3.0	100

Table 16

Breakdown of Total Labor Content of Repairs to Ships of the Maritime Fleet, for the Hull Sections (In Percent)

Ship Type [1]	Boiler Sections: In Shop [2]	Boiler Sections: In Ship Hoists [3]	Boiler Sections: In Water [4]	Boiler Sections: Total [5]	Wood-working [6]	Paint-ing [7]	Rig-ging [8]	Sail-making [9]	Total [10]
Capital Repair									
Cargo steamships	6.9	31.0	21.6	59.5	25.0	10.0	2.8	2.7	100
Cargo Diesel ships	6.7	30.3	21.0	58.0	26.0	10.5	2.8	2.7	100
Cargo-passenger steamships	7.0	30.0	21.0	58.0	29.0	6.0	2.5	4.5	100
Cargo-passenger Diesel ships	7.0	29.6	20.4	57.0	29.5	6.4	2.6	4.5	100
Oil tankers	7.2	37.2	31.6	76.0	15.0	6.0	1.3	1.7	100
Steam tugs	10.5	48.5	--	59.0	24.6	11.0	3.4	2.0	100
Motor cutters	9.5	44.5	--	54.0	32.0	12.0	2.0	--	100
Earth-pumping scows	10.5	43.2	17.3	71.0	14.5	8.2	5.5	0.8	100
Dredgers	10.5	42.8	17.2	70.5	14.7	7.9	6.2	0.7	100
Dry-cargo barges	8.3	54.5	19.2	82.0	12.0	4.7	0.7	0.6	100

[continued]

[Table 16, continued]

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Medium Repair									
Cargo steamships	2.5	9.7	19.3	31.5	34.4	22.5	5.8	5.8	100
Cargo Diesel ships	2.4	9.4	18.7	30.5	34.5	23.5	5.75	5.75	100
Cargo-passenger steamships	2.3	10.0	19.7	32.0	41.5	12.8	5.5	3.2	100
Cargo-passenger Diesel ships	2.2	9.6	19.0	30.8	43.0	12.5	3.4	8.3	100
Oil tankers	3.8	23.9	16.0	43.7	29.0	[illegible]	3.7	5.6	100
Steam tugs	7.5	27.4	12.4	47.3	27.8	16.7	4.5	3.3	100
Motor cutters	6.6	24.2	11.0	41.8	38.4	16.2	3.6	--	100
Earth-pumping scows	4.6	36.3	14.4	55.3	15.0	16.4	11.8	1.5	100
Dredgers	4.5	35.7	14.2	54.4	14.8	16.0	13.4	1.4	100
Dry-cargo barges	7.6	44.0	22.4	74.0	15.5	8.0	1.5	1.0	100

Table 17

Breakdown of Total Labor Content of Repairs to Ships of the Maritime Fleet, for the Mechanical and Preparatory Sections (In Percent)

Ship Type [1]	Machine-Assembly Work: Mechanical [2]	Machine-Assembly Work: Manual [3]	Repair and Installation: Machinery [4]	Repair and Installation: Pipelines [5]	Welding [6]	Copper- and Tinsmithy [7]	Electrical Repair [8]	Forging [9]	Casting [10]	Total [11]
Capital Repairs										
Freight-passenger steamships	25.5	22.0	13.0	16.0	4.0	2.0	9.5	3.0	5.0	100
Freight steamships	26.0	22.0	13.0	15.5	4.5	2.0	8.0	3.5	5.0	100
Steam tugs	24.0	22.0	17.0	10.0	4.0	3.0	12.5	3.0	4.5	100
Freight Diesel ships	18.5	17.0	12.0	12.0	2.5	2.5	27.5	2.5	5.0	100
Industrial and service-auxiliary Diesel ships	20.0	18.0	13.0	13.0	3.0	2.5	24.0	2.5	4.0	100
Freight-passenger Diesel ships	19.0	17.0	12.5	12.0	2.5	2.5	26.5	2.5	5.5	100
Dredgers	25.0	23.0	17.0	10.0	11.0	1.5	5.0	1.5	6.0	100
Earth-pumping scows	24.0	23.0	18.0	11.0	9.5	1.5	6.0	1.5	5.5	100
Motor cutters	24.5	27.5	12.0	9.5	4.5	2.0	11.5	2.5	6.0	100
Dry-cargo iron barges	19.0	16.0	24.5	--	2.5	19.5	--	14.0	4.5	100

[continued]

[Continued, Table 17]

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
Medium Repairs										
Freight-passenger steamships	16.5	34.5	22.5	11.5	2.5	4.0	5.0	1.0	2.5	100
Freight steamships	16.0	34.0	26.5	10.0	2.5	3.0	4.5	1.0	2.5	100
Steam tugs	14.0	37.0	22.0	9.5	3.0	3.5	6.0	2.0	3.0	100
Freight Diesel ships	15.0	23.5	23.5	8.5	2.0	3.0	20.0	2.0	2.5	100
Industrial and service-auxiliary Diesel ships	15.0	24.0	18.5	10.5	2.0	2.5	23.0	2.0	2.5	100
Freight-passenger Diesel ships	15.0	23.0	24.0	8.5	2.0	3.0	19.5	2.5	2.5	100
Dredgers	16.0	36.5	21.5	7.5	6.5	1.5	3.0	1.0	6.5	100
Earth-pumping scows	15.5	35.5	23.5	9.0	5.5	1.0	3.5	1.0	5.5	100
Motor cutters	22.0	37.5	15.5	9.0	3.0	2.0	6.5	2.0	2.5	100
Dry-cargo iron barges	14.0	17.0	38.0	--	2.0	24.0	--	3.0	2.0	100

Using the data contained in Tables 13 through 17 and the indexes obtained from the graphs in Figures 11 through 14, one may establish for each ship a calculation program for the labor content of work in any section of the installation.

Thus, with precision sufficient for the design project (in three-stage designing), one may calculate the loading of each section of a ship-repair enterprise and thereby determine its dimensions and necessary equipment.

The use of the indexes of total labor content of ship repairs can be used for calculation purposes only when it is necessary first to establish the dimensions of the basic sections and equipment of the enterprise in order to determine the dimensions of a section or to compare a number of alternatives and select the best one.

The loading of the sections of the preparatory group is in this case calculated from the indexes of issuance of castings, forgings, and dry and sawn timber, in goods units, i.e., in tons of castings and forgings and cubic meters of processed timber.

The loading of sections has hitherto been calculated in terms of materials indexes only in working out plans for maritime ship-repair enterprises. In this case the quantity of material processed in each section for standard representative ships is usually determined by selection from the norm of materials consumption (on the basis of which reports are submitted to the preparatory organizations) for each category of repair.

Figures 15 and 16 show the indexes of materials consumption in the pipeline and woodworking sections as a function of the capacity of the principal machines and the volume (LBH) of the hulls of metal maritime ships in capital and medium repair.

The accuracy of these norms, compiled on the basis of data obtained from repair reports for standard ships and extended to other ships in each group according to appropriate coefficients, cannot be considered sufficient for working out the designs of sections.

In order to calculate loading one must determine the labor content of repairs in each section of the enterprise. This calculation is based on data on the specific labor content of processing the basic materials, expressed in units of weight or volume of materials processed.

Determination of materials consumption in each section is usually necessary only for the calculation of transport loading and the dimensions of storage areas for the sections and for the installations as a whole.

If in calculating loading of sections by labor content these relatively inaccurate data are used only to determine materials consumption in each section, then when calculation is done in terms of materials indexes the entire design of the section is based on these indexes.

In designing ship-repair and shipbuilding enterprises these calculations do not require particularly precise foundations. In addition the indexes of specific labor content per unit of materials consumed in current repairs, and particularly in in-voyage repairs, do not coincide with practical data.

This is explained by the fact that in these categories of repair negligible quantities of materials are consumed with considerable expense of manual labor. Naturally this method of calculation for the design of ship-repair enterprises which are loaded basically with current and in-voyage repairs (ship repair shops) cannot be recommended.

In working out the design problem for a shipbuilding dock the method of technical indexes may sometimes be justified even for more precise calculations when this method is based both on weight indexes for the consumption of materials in terms of the data on the technical design of the ship, and on the indexes of specific labor content by individual sections (per ton of weight of metal processed or per cubic meter of lumber used).

The table presented below shows the specific labor content per ton of weight of hull metal for all operations in the construction of a metal hull for a 400-horsepower paddle-wheel steam tug:

Item	Man Hours
Leveling on rolls	3.2
Manual leveling	2.0
Marking out	7.2
Cutting with shears	3.1
Torch cutting	2.0
Surface cleaning	1.0
Other preparatory work	2.0
Machine bending of sheet	3.0
Manual bending of sheet	5.8
Manual bending of shaped profiles	4.2
Total for preparatory operations	33.5
Assembly	74.0
Welding	26.0
Testing of water-tightness	7.0

This method can be employed to determine the loading of the sections of an installation by using technical indexes obtained from the design of the calculation ship and designs of shipbuilding docks intended for the construction (using a standard method) of ships identical to the calculation ship.

The percentage relationships among the labor content of all types of work on ship construction can be used for calculating the loading of other sections.

By way of example the table below presents a breakdown of the labor content, in percents, in the construction of a 400-5?? horsepower metal screw-type steam tug:

Item	Percent
Hull work	60-80
Installation and pipeline work	4-6
Mechanical installation work	7-9
Hull finishing and painting	12-15
Electrical work	6-8

Table 18 presents a breakdown of labor content in the large-series construction of a maritime cargo steamer of 2,000 tons' displacement with a welded hull; the total labor content was 197,000 man-hours.

Table 18

Breakdown of the Labor Content on the Construction of a Maritime Cargo Steamer of 2,000 Tons' Displacement

Item	1,000 Man-Hours	Percent
Hull work	83	41
Woodworking, rigging, and sail-making	11	6
Mechanical and installation	85	42
Pipeline	12.9	8
Finishing and delivery	5.6	3

The labor content by individual sections may be obtained from data on the specific labor content for processing and assembling individual structural units of the ship in production sections. For example, in the pipeline-copperworking section the specific labor content for individual types of work per ton of material processed was as follows:

Item	Man-Hours per Ton
Pipeline work	245
Copperwork	1,000
Tinsmithing	600
Pouring work	200

The indexes for the labor content in building a single twin-screw steel river cargo ship with a capacity of 600 tons, a hull measuring 67 x 8.2 x 3, and a 250-horsepower Diesel engine, are presented in Table 19.

The specific labor content for the preparation of a metal hull for a single ship varies, according to careful calculations: around 117 man-hours per ton of metal hull for an oil-tank barge; around 220 man-hours per ton for an earth-pumping scow; around 260 man-hours per ton for a port tug; around 220 man-hours per ton for a river cargo Diesel ship; up to 350 man-hours per ton for a passenger ship; and up to 410 man-hours per ton for a small paddle-wheel steam boat.

The specific labor content for carpentry work varies from 110 man-hours per net cubic meter of wooden parts for a motor cargo boat to 300 man-hours per cubic meter for a passenger ship.

The specific labor content for cabinetmaking to equip the cabins varies from 215 man-hours per net cubic meter for a cargo ship with simple finish to 355 man-hours per cubic meter for a motor ship with furniture and 485 man-hours for a small paddle-wheel steamship with furniture.

The specific labor content for preparing and installing ship equipment and parts per ton of their weight varies from 350 man-hours for a Diesel cargo ship to 1,250 man-hours for a passenger steamship. The specific labor content of painting ranges from 16 man-hours per ton of weight for a ship without cabins (for a motor cargo ship) to 34 man-hours per ton of weight for a small paddle-wheel steamship with cabins and furniture.

In calculating weight, some allowance must be made for the percentage of waste in obtaining the net weight of structural parts of a ship over the raw weight of the material used, as follows:

Item	Percent
Profile steel	8
Sheet steel	7-10
Forged parts	Up to 30
Structural lumber (% of sawn timber)	15-25
Cabinetmaking lumber	30
Pipe	10
Cast iron parts	10

The specific labor content, i.e., the indexes of labor content, for ship construction per ton of hull fittings (equipment and auxiliary machinery) in the construction of single self-propelled river ships varies from 350 to 685 man-hours, depending on the complexity of fittings and their weight.

The specific labor content per ton of wooden fittings and furniture varies between 300 and 600 man-hours depending on the finish.

The indexes of specific labor content in developing designs for serial-production shipbuilding enterprises should be more precise.

The table below shows the specific labor content, in estimated hours, for building river and lake ships per ton of weight, based on data from transport shipbuilding installations (not taking account of the readjustment norms and the labor content of coordinated production operations).

Item	Hours
Twin-screw diesel tug, 600 HP	356
Twin-screw dry-cargo diesel, 2,000 tons, 800 HP	200
Paddle-wheel steam tug, 400 HP	248 and 289
Paddle-wheel steam tug, 200 HP	433
Dry-cargo open metal barge, 3,000 tons	147
The same, 1,400 tons	200
The same, deck-type, 800 tons	143
Tank barge, 2,000 tons	186
Tank barge, 5,000 tons	212
Cargo diesel ship, 1,000 tons (according to design data, taking account of the reworking of norms)	160

The specific labor content of hull work per ton of hull weight of a ship varies from 157 estimated hours for a 2,000-ton Diesel cargo ship whose metal hull weighs 412 tons, to 135 estimated hours for a 1,000-ton Diesel carbo ship whose metal hull weighs 275 tons, (according to the Plan, with Diesel ships built in enclosed shipbuilding docks in series of no less than 30 ships per year), to 145 estimated hours for 800-ton deck-type barges with hulls weighing 126 tons.

SECTION 25. CALCULATION OF LOADING IN TERMS OF ECONOMIC INDEXES

The method of calculating loading in terms of economic indexes may be recommended only as a preliminary step to the determination of the scope of production and the required area of a ship-repair enterprise.

This method of calculation has been used to work out technological repair data, and the results obtained frequently differ sharply from actual facts.

This method is based on the use of economic indexes of an actual enterprise for the determination of the necessary scope of production of an expanded enterprise while retaining the nature of its loading. Thus this method assumes complete identity of the nature of repair work and the types of ships repaired in expanding the production of the reconstructed enterprise.

On the basis of report data of the last 2 or 3 years, retaining the loading determined for the ship-repair enterprice, annual production in rubles is determined per individual production worker.

If B = the total annual production of a ship-repair enterprise in rubles, and Y the number of hours worked per year by the production workers, then the index of total production per man-hours is

$$b = \frac{B}{Y}$$

Total production of the installation includes the cost of all work of an industrial nature performed during the report period (the year) and the finished and semifinished products produced (both from the installation's own material and from the parts and semifinished products of the client), minus the cost of the finished and semifinished products of the installation's own production consumed for production purposes, regardless of whether the finished and semifinished products deducted were produced during the report period or earlier.

It should in addition be shown that in machine building, shipbuilding, and ship-repair enterprises total production includes increases (decreases) in the value of uncompleted production during the report period.

On the basis of report data expenses for repairs of all types of ships in the calculation program are established for the three categories of repair and the cost of operation determined for ship repair for the reconstructed enterprise.

The complete calculated value of total production for a planned enterprise, after reconstruction, is

$$B_1 = C_p + 0.1\ C_p + 0.15\ C_p,$$

which includes expenses of 10 percent for the production of spare parts and 15 percent for loading of the enterprise itself for service purposes over the calculated amount of C_p, which is the annual volume of ship repair.

The number of productive workers equals: $P = \frac{B_1}{1.3 F_p}$,

where F_p = the annual time fund of the worker, while the coefficient 1.3 takes into account increased labor productivity equal to 30 percent.

According to report data, when the type of loading has been established, each ship repair enterprise retains a definite relationship among the costs of operation for individual sections. Thus in the case of river installations which have ship-hoisting equipment, with relatively small load of current repairs and no repairs to earth-pumping scows and cargo-passenger ships in the program, total production is divided up among the sections in the following percentage relationship, on the average:

Item	Percent
Hull	28
Machine-assembly	20
Pipeline-copperworking	8
Woodworking	12

[continued]

Item	Percent
Electrical repair	4
Painting	8
Rigging and sailmaking	4
Casting	5
Forging	5
Sawing	5

The necessary number of productive workers can be determined from data on the costs of production expressed in man-hours in each section. The number of auxiliary workers is determined as a percent of the productive workers and varies from 13 for hull sections, to 20 for woodworking, forging, and casting sections, to 25 for machine-assembly sections.

The number of workers necessary in the auxiliary sections is determined as a function of the number of workers and of the number of machine tools in the productive sections. Thus the tool sections require metal-cutting machine tools equal to 14-18 percent of the number of machine tools in the machine-assembly section. The repair-mechanical section requires machine tools equal to 10 percent of the machine tools in the machine-assembly section. It should be noted that these indexes can be used only for preliminary calculations. In this method machine-tool equipment is selected according to standard proportions.

Thus the method considered envisions preliminary calculations for the reconstruction of an existing enterprise retaining the working methods and organization of production which were employed previously.

SECTION 26. THE STATISTICAL METHOD OF CALCULATING LOADING

The statistical method of calculating the loading of sections in designing a ship-repair enterprise, like the method of calculation according to economic indexes, uses existing relationships among the numbers of workers in individual sections and the relationships among types of machine tools in the machine-assembly section with a normal complement of machine tools in the steel sections; it thus envisions retaining in the planned enterprise the methods of work and production organization established in the majority of ship-repair enterprises in the basin.

One of the first efforts in the methodology of designing river ship-repair enterprises was that of Engineer A. D. Ryabov published in the symposium of the Scientific Research Institute of Shipbuilding and Ship Repair in 1931; here he proposed a statistical method of calculating the loading of a planned ship-repair enterprise.

This method may be used only in working out the plans for a small expansion of existing ship-repair shops the volume of whose operation does not exceed 300,000-400,000 man-hours per year. In doing so a study must be made of a number of ship-repair enterprises in the region with analogous operations, and relationships must be established among the numbers of workers in the various sections and among the types of machine-tool equipment in the machine-assembly section.

SECTION 27. THE SELECTION OF A METHOD OF CALCULATING LOADING

We have considered five methods of calculating the loading of shipbuilding and ship-repair enterprises.

Hereinunder, for ship-repair enterprises, we shall use the second method -- based on standard technological data on the repair of calculation (standard) ships according to the proposed program; and the third method -- based on technical date of labor content. For shipbuilding enterprises we shall use the first method -- based on technologgical processes in construction according to a precise

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program; the second method -- based on standard technological data on the construction of calculation ships according to the proposed program; and the third method -- based on technical indexes of materials consumption.

Depending on the problems faced in individual stages of the design of shipbuilding and ship-repair enterprises one or another of the above methods of calculating the loading of sections should be used. Specifically, in working out the design problem the simplest of the proposed methods of calculation -- that based on technical indexes -- may be used for shipbuilding and ship-repair enterprises, since this method requires only the same precision of calculation for the basis of selecting the best of the proposed solutions.

In working out the technical design of ship-repair enterprises (in which final decisions will be made on the methods of handling parts produced and assembling them in the structural centers, the dimensions of all sections, and the selection and placement of equipment) the second method is recommended -- that based on standard technological data on the repair of calculation (standard) ships according to the proposed program.

The technical design of shipbuilding enterprises (which include in their program new types of ships which have not been previously built at existing enterprises and the technology of whose construction has not been worked out in previous designs) is based on previously worked-out technological processes for the construction of ships according to a precise program. This method should also be used in working out the technical design of a shipbuilding dock with a program of building ships of familiar types, the construction of which must be organized using new methods of work or of organization, and of dockyard assembly of ships.

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In all cases in which technical designs are being worked out for shipbuilding docks intended for the production of ships using established methods for the construction and assembly of ships in dockyards, the simplest method of calculating the loading of sections should be used based on standard operational data on the construction of calculation ships according to the proposed program.

When these requirements have been fulfilled it will be possible to work out designs for shipbuilding and ship-repair enterprises with accuracy sufficient for each stage of design and at the same time with the minimum expenditure of time and resources.

Table 1[illegible]

Breakdown of Labor Content in Building a Maritime Cargo Steamship of 2,000 Tons' Displacement

Type of Work	Labor Content: 1,000 man-hours	Labor Content: Percent
Hull	83	41
Woodworking, painting, and rigging	11	[illegible]
Mechanical and installation	[illegible]	42
Pipeline	12.9	[illegible]
Finishing and delivery	5.6	3

Table 19

Labor Content in the Construction of a Single Twin-screw Diesel Ship of 600 Tons Capacity, Hull Dimensions 67 x 8.2 x 3 meters, and 250 Horsepower

Type of Work	Material Weight or Volume	Man-Hours per Ton	Man-Hours per Cu m	Total Labor Content, Man-Hours	Total Material Weight or Volume
Preparatory and auxiliary work (lumber, launching equipment, etc)	--	--	--	3,184	--
Work on metal hull:					
Sheet steel	128.2 tons	305	--	50,638	166 tons
Profile steel	37.8 tons				
Total	166.0 tons				
Carpentry	20.5 cu m	--	185	3,800	13.[illegible] cu m
Equipment, and machine installation (rudder and anchor equipment, hoists, turbine lines, etc)		585	--	7,351	12.77 tons
Wood finishing		--	185	2,750	11.8 cu m
Manufacture of furniture		335	--	1,205	3.6 cu m
Manufacture of deck inventory (anchors, rope, cable)		--	--	500	5.93 tons
Installation of the mechanical department (installation of principal engines, fuel tanks, shaft lines, and turbine lines of auxiliary machinery)		163	--	3,600	22.2 tons
Total labor content (painting included in individual work groups)	--	--	--	73,026	--

CHAPTER X

THE TIME FUND FOR EQUIPMENT AND MANPOWER

SECTION 36. GENERAL PRINCIPLES Pages 114-115

The basic funds of a socialist enterprise should be used most effectively and should provide for maximum production. Therefore at all enterprises which do not require continuous production processes the equipment should operate no less than two shifts per day, i.e., 16 hours. The number of working days per year is taken as maximum, equal to 365 - 52 - 6 = 307 (52 days off + 6 holidays).

The production processes of some sections are performed consecutively on the same production area, and individual types of equipment are used in only a single shift. For example, in an iron-casting section which produces heavy castings (castings standard for ship-repair installations using earth molds) all processes -- molding, pouring, and removal -- are performed in the same area, i.e., according to the principle of the division of production processes with respect to time and not with respect to place. If molding is done during the first shift, casting during the second, and removal during the third then obviously the equipment intended for each operation will be used on only one shift and a single-shift system is taken for its calculation (as it is for production areas) although the entire section is occupied for three shifts.

In the mechanical sections of ship-repair enterprises with a small volume of coordinated production large machine tools are installed (for working bulky parts) the loading of which frequently cannot be assured fully even for a single shift. The lack of these machine tools, on the other hand, might cause delays in ship repairs the cost of which would considerably exceed the amortization write-off from supplementary basic funds for the acquisition of large machine-tool equipment and the preparation of production areas for their installation.

Naturally if coordination is well organized both among ship-repair installations in the basin and through obtaining bulky ship parts from industrial plants, it is possible to equip the mechanical sections of ship-repair enterprises only with that equipment which will be sufficiently loaded.

The necessity of providing for systematic inspections, small equipment repairs, and the preparation of production for the third shift compels the ship-repair and shipbuilding enterprises to limit their operations to two shifts. This is justified also by the difficulties which arise in performing installation and dismantling work on ships at the end of the second and during the third shift.

The length of the working day, for purposes of designing machine-building enterprises, is taken as equal to 8 hours for ordinary operations and 6 hours for particularly dangerous ones, in accordance with the labor law of the Soviet Union.

The annual continuous vacation for each worker in ordinary production processes has been established at 12 working days. For particularly dangerous production processes and others specially listed the continuous vacation equals 24 working days per year.

The loss of working time for acceptable reasons is taken as not more than 4 percent of the total annual time.

In order to provide for uninterrupted operation of machine tools and machinery, planned-compulsory repairs are envisioned. Therefore the quantity of equipment determined by calculations is to be increased in proportion to the time necessary for its repair.

In order to avoid the necessity of increasing the quantity of unique and expansive equipment, the annual time fund for its operation is, where necessary, increased through the partial use of a third shift.

To take account of time lost in repairs all equipment is divided into large, complex, medium-sized, and small.

The first period of repair is taken as equal to not more than 5 percent of the annual time fund and the second not more than 3 percent.

SECTION 37. CALCULATION OF THE TIME FUND

The calculated annual time fund for the operation of equipment is determined according to the formula:

$$F_o = (365 - 6 - 52)\ c\ 8\ k \qquad (17)$$

where c = the coefficient of the number of shifts, and

k = a coefficient which takes into account equipment downtime due to repairs.

The calculated annual time fund for workers in ordinary sections is:

$$F_{p_1} = (365 - 52 - 6 - 12)\ 8\ k_1$$

where $k_1 = 0.96$.

The annual time fund of the workers in sections which have adopted lengthened, staggered vacations, is:

$$F_{p_1} = (365 - 52 - 6 - 24)\ 8\ k_1.$$

The annual time fund for workers in injurious operations is:

$$F_{p_2} = (365 - 52 - 6 - 24)\ 6\ k_1.$$

SECTION 56. THE SELECTION OF TYPE AND DIMENSION OF SHIP-HOISTING EQUIPMENT AND THE CALCULATION OF ITS LOADING

Pages 193-204

The selection of the type of ship-hoisting equipment depends on a number of factors including:

1. The configuration of the area of the ship-repair enterprise.

2. Hydrological and geological characteristics of the area around the enterprise.

3. The duration of the ice season on the water

4. The number of ships which must be hoisted annually.

5. The number of ships requiring capital and medium repairs.

6. The basic dimensions of various ships included in the operational program of the installation.

7. The degree of immersion of ships to be hoisted.

8. The dock weight of ships.

Crowding in the territory of insufficient length of mooring dock coupled with weak carrying capacity of the ground makes it necessary, other things being equal, to consider the use of floating ship-hoist equipment -- floating docks -- under the conditions of maritime ship-repair enterprises. Large variations in water level also sometimes create favorable conditions for the use of floating docks. At the same time a long ice period on the water of a ship-repair enterprise coupled with the necessity for simultaneously hoisting a large number of ships onto the shore reduces the technical-economic indexes of the alternative of using floating docks and creates the most favorable conditions for the selection of multi-place shore ship-hoisting equipment, i.e., a lock-type dock or slip.

Capital and medium repairs to ships require the presence of shore ship-hoisting equipment located close to the enterprise's basic productive sections and service equipment.

It should be noted that the cost of shore ship-hoisting equipment -- dry dock, launchway, and slip -- depends to a considerable degree on the length of the ship and the degree of its immersion at the time of docking. In determining the dimensions of shore ship-hoisting equipment particular attention should be given to the technical-economic usefulness of the maximum length and degree of immersion selected.

The cost of operating a dry dock depends to a considerable degree on the consumption of electric power (which is in turn determined by the volume of water which must be pumped out in docking) and on the amount of amortization write-offs, i.e., the cost of the dock, and thus on the dimensions of the largest ship which the dock can handle. In docking ships whose dimensions correspond to those of the calculation ship the volume of water pumped out will be minimum and the dock will be used with maximum effectiveness. On the other hand when small ships are docked the volume of water to be pumped out increases and the dock is being used inefficiently.

When ships are hoisted by a floating dock the weight of the water pumped out only slightly exceeds the weight of the ship being hoisted. Thus when it is necessary to hoist at one enterprise a relatively small number of ships differing in length and degree of immersion a floating dock will be used efficiently and its use may be justified under the conditions of a maritime ship-repair installation even for capital repair.

The basic advantages of a floating dock are the speed of hoisting and the possibility of using a large crane to hoist ships which have been damaged. When it is very difficult to bring loads from the shore to the floating dock, conditions for its efficient utilization may be created only for current repairs or for the repair of local damage to the ship hulls. In this case the floating dock is used efficiently for hoisting numerous ships throughout the entire period, and not for keeping a single ship in the dock over a long period.

For capital and medium repairs on large maritime ships differing only slightly in dimensions dry docks will be most efficient, provided the geological and hydrological conditions favor their construction.

The considerations presented above show that a number of factors enter into the selection of the type of ship-hoisting equipment. The selection of the optimum solution to this problem, in order to achieve minimum capital investment, lowest cost of ship-hoisting equipment, and best operation of the equipment for the proposed program, requires a number of preliminary technical-economic calculations.

Determination must be made of the loading of the ship-hoisting equipment and the number of docks simultaneously loaded with ships under repair.

The operating conditions of river transport require the complete removal of the underwater portion of ships only during capital and medium repairs. During current repairs docking may be necessary only as a result of injuiies to the underwater portion of the ship, poor repair, and bad handling. If there is a large number of old ships in the fleet or there are particular operating conditions (insufficient depth over sandbars, the necessity for the ships to pass through sections full of rocks and rapids), it may be assumed that during the periods between medium repairs 25-30 percent of the ships in individual river basins will be undergoing current repair.

Wooden ships with insufficient linear strength are as a rule docked once a year. This makes it necessary to include in the loading of ship-hoisting equipment annual docking of no less than one-half the wooden ships of the river basin requiring current repair.

The normal span of operation of maritime transport ships between dockings is presented in Table 3.

The period during which a ship undergoing capital or medium repair remains in the dock or the slip depends basically on the mechanization of labor and the use of trains and mechanized horizontal transport within the installation. Experience gained from repairs on floating docks at a number of large ocean-transport installations makes it possible to assume that with the proper organization of work docking for current repair (including cleaning and paiting underwater parts, examination and repair of all hull openings) of a large maritime ship may be completed with 2 to 4 days.

The calendar graph of the completion of dock work in the mechanical section for medium and capital repairs of cargo-passenger ships around 100 meters in length and 1,500 horsepower (Figure 57) shows that the medium repair of a maritime transport ship in a dock can be completed within 14-18 days under normal conditions and with the necessary mechanization of basic operations. The period of capital repair in the dock is determined obviously by the hull work, which lasts at least as long as the repairs on the mechanical portion of the ship.

The calendar graph, presented in Figure 58, showing capital repair in a dock to the hull of a maritime cargo ship of the lumber-carrying type displacing 3,000 tons, fixes the time for completion of this category of repair at 45 days. The graph was compiled from the calculation of repairs on a riveted ship not using modern methods of sectional repair of the ship hull employing cranes on the docks and in the slip.

Modern methods of repairing welded ships makes possible a considerable acceleration in the rate of completion of repair work and a reduction in the length of time ships are in the ship-hoisting equipment. Report data on the actual time spent by ships in docks and slips in various categories of repair make it possible to establish mean calculation times which can and must be reduced in the rational organization of ship repair and the mechanization of laborious work in docks.

Table 36 presents mean calculated lengths of time ships of individual types remain in docks. These times should be reduced through improving organization and increasing the technical level of production.

The number of dock places C in ship-hoisting equipment in navigation throughout the entire year may be determined from the following expression:

$$C = \frac{\sum \gamma_K K_K + \sum \gamma_c K_c + \sum \gamma_T K_T}{\;} \qquad (34)$$

where γ_K = the number of ships of various types in each group requiring capital repair (according to the calculation program);

γ_c = the same for capital repairs;

γ_T = the same for current repairs (requiring docking);

K_K, K_c, K_T = duration of ships in the dock by groups for capital, medium, and current repairs (following Table 36);

F_d = the annual time fund for work of ship-hoisting equipment; with navigation throughout the year F_d = (365 - 52 - 6)0.96 = = 294.

The coefficient 0.96 takes account of the time necessary to repair ship-hoisting equipment. When the water in which the ship-hoisting equipment is located freezes the fund of its working time is reduced correspondingly. In this case the necessary number of dock-hours in the numerator of the expression given above should be determined only for loading of ship-hoisting equipment during the summer. If the ships raised in the slip include those of various lengths, the possibility must be taken into account of hoisting simultaneously 2 or 3 ships at a single dock place.

During the season when the water is frozen the floating dock should be used for capital repairs of the largest ships. The slip should be used during the winter for medium and capital repairs on transport ships.

It is usually considered possible, in addition to the basic winter loading of the slip of a river ship-repair enterprise, to place in the slip ships requiring medium repair 15 days before the freeze-up and 15 days after the ice breaks up.

After the water has been cleared of ice the slip is used for medium repairs on scows, while throughout the summer the slip is used for capital repair and current docking of the transport fleet. In addition some of the dock places of the slip are reserved during the summer months for building ships.

In selecting the type of ship-hoisting equipment, in addition to the considerations enumerated above, attention should be directed toward the advantages and disadvantages of each. It should be noted that hoisting and lowering operations using sluices are dangerous; they are efficient only for ships weighing up to 200-300 tons, and they should be used primarily for capital repairs of wooden barges.

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The basic advantages of the transverse slip are: (a) Large capacity with independent lowering of ships; (b) The possibility of rapid hoisting of ships out of the water; (c) Convenience of material-consuming work (supply of materials, liaison with sections, crane servicing); (d) Operational efficiency.

The basic shortcomings of the transverse slip include: (a) The considerable complexity of the mechanical and electrical equipment; (b) The difficulty of repairing the underwater portion of the hoistway; (c) The complexity of placing keel ships in the dock; (d) The great area required for placement of structures.

The basic advantages of the linear slip include: (a) The small length of the mooring line required; (b) The possibility of providing easily for the movement of trucks without turns; (c) The simplicity and reliability of equipment; (d) The relatively low cost of the underwater portion and machinery.

The basic shortcomings of the linear slip include: (a) Greater complexity of placing the ship on trucks than in the transverse slips; (b) The presence of back pressure at the moment of placing the slip on the trucks, thus preventing the use of this type of structure for ships of weak construction and particularly for river ships; (c) Greater water depth at the entrance than in the case of transverse slips, which may complicate construction operations; (d) The need for help in lowering the majority of ships raised since only two ships may be lowered independently; (e) The considerable length of docks and their location beyond the territory of the installation, which makes crane-servicing of the docks difficult; (f) The difficulty of sending ships to the side docks.

The basic shortcomings of ship-hoisting slipways (linear and transverse) are their small capacity, which makes them unprofitable under the conditions of a ship-repair installation which keeps ships throughout the winter, and creates difficulties in using cranes and intra-installation transport to service ships in the slipways.

The advantages of the box-type floating dock include: (a) Inexpensive construction of the dock in comparison with other types of docks; (b) Simplicity of placing ships in the dock.

The basic shortcomings of the box-type floating dock include: (a) Poor linear strength; (b) Water permeability; (c) Limited load capacity; (d) The impossibility of self-docking for repair purposes; (e) Small capacity, limited to one place.

The advantages of the pontoon-type dock include: (a) The simplicity of erection and speed of hoisting ships; (b) The possibility of self-docking; (c) Sufficient linear strength; (d) The possibility of using part of the dock length (some of the pontoons); (e) Small number of service personnel.

The shortcomings of the pontoon-type floating dock include: (a) The complexity of administration and the requirement for highly skilled service personnel; (b) The necessity of creating a deep basin for placement of the floating dock and special equipment to connect the dock with the shore; (c) Small capacity.

The basic shortcomings of the box-type and pontoon-type docks include: (a) The difficulty of working in a water area which is poorly protected from the effects of weather, waves, ice, and current; (b) The impossibility of using cranes placed on the shore and the difficulty of transporting loads from the shore; (c) Difficult working conditions.

The advantages of dry and lock-type docks include: (a) Convenience, simplicity, and safety of placing ships in the keel blocks; (b) The lack of limitations in the dimensions and weights of ships hoisted; (c) The small length occupied by the mooring lines of the installation; (d) The possibility of using cranes located on the land around the installation; (e) The possibility, given favorable natural conditions (a drop in the water level), of reducing operating costs by using the riverflow for the water supply.

Shortcomings of dry docks include: (a) The high cost and long duration of construction; (b) The high cost of operation in hoisting ships smaller than the calculation dimensions; (c) The dependence of operation on variations in water level; (d) Difficult working conditions.

It should be pointed out, furthermore, that in large lock-type docks the transportation of loads and the use of cranes is difficult over the entire area.

As has already been pointed out the selection of the type of ship-hoisting equipment should be based on operational considerations together with the solution of the general plan of the entire ship-repair enterprise; it should be based also on technical-economic calculation providing a rational basis for selecting a solution.

Under the conditions of capitalist production the solution of the problems of the rational selection of ship-hoisting equipment is subordinated to the interests of extracting the maximum profit by each entrepreneur. The selection of ship-hoisting equipment by capitalist enterprises leads usually to small-capacity equipment (floating docks, transverse and linear slipways). Under the conditions of harsh competition and in the absence of the planned development of ship-repair enterprises the construction of large-capacity ship-hoisting equipment is unprofitable. As a result even large ship-repair enterprises, developing in stages, have installed several single-place ship-hoisting units (floating docks, single-place slipways) of random dimensions.

The planned system of the national economy of the Soviet state makes possible the most profitable and rational solution of the problem of equipping ship-hoisting structures together with the development of ship-repair bases in each water region. The creation of large hydraulic centers on the important rivers of the Soviet Union simultaneously with the solution of transport problems makes it possible in a still greater degree to concentrate capital and medium repairs in a small number of well-equipped ship-repair enterprises. All of this makes for the most efficient development of ship-hoisting structures through the construction of multi-place equipment -- ship-hoisting slips -- with the minimum capital investment per dock-place.

The simpler and more highly perfected plans worked out by Soviet designers for ship-hoisting slips makes possible their effective use for river and maritime ship-repair enterprises hoisting ships weighing up to 4,000-6,000 tons.

The method of constructing the underwater portion of slips used at the present time by Soviet builders, without cofferdams and using divers, provides maximum efficiency in the construction of slips for hoisting maritime ships with great depths at the entrances.

Thus simply for hoisting a small number of very large ships and for current repairs on other ships it is efficient to use metal floating docks for maritime installations and wooden floating docks for river ship-repair installations.

One of the basic factors influencing the selection of the type of ship-hoisting equipment is its cost. Figure 59 contains a diagram of capital investment per dock-place as a function of various types of ship-hoisting equipment for river ship-repair enterprises. For calculation standard 3,000-ton dry-cargo metal barges measuring 85 x 14, and 600-horsepower twin-screw Diesel tugs measuring 40 x 8, were used.

It follows from the figure that if the number of ships hoisted simultaneously does not exceed two it is desirable to use floating box-type wooden docks for river enterprises. If the number of dock-places is more than seven the cheapest construction is a ship-hoisting slip. It should be pointed out that recent work has demonstrated some reduction in the calculation of costs of dry docks and lock-type docks which, when the drop in water levels at dams is exploited, usually require considerable expense for surrounding structures.

The diagram of the cost of docking, constructed from data by Engineer D. I. Zinevich, as a function of the type of ship-hoisting equipment and the number of dock-places (Figure 60) shows the identical efficiency of using dry docks, lock-type docks, and slips with a small number of dock-places in the construction of river enterprises.

It should be pointed out, however, that practice in the construction of slips in recent years has shown a considerable reduction in cost and operating expenses through standardization of equipment and simplification of structural designs.

The diagram shown in Figure 61 presents comparative data for all types of ship-hoisting equipment and makes it possible to determine the economic efficiency of their application as a function of the number of necessary dock-places.

Wooden box-type docks are efficient in operation when two dock-places are used simultaneously, while multi-place dry docks and lock-type docks may be used efficiently when up to six ships must be hoisted simultaneously. When more ships must be hoisted simultaneously the most efficient ship-hoisting equipment for river installations is the transverse slip.

In constructing the above diagrams the following conditional amortization write-offs were assumed: for dry docks, 2.5 percent; metal floating docks, 3.5 percent; wooden docks, 5 percent; slips on concrete piles, 2 percent; temporary wooden sluices, 30 percent; all types of fittings, 50 percent.

In calculating the costs of maintenance of ship-hoisting equipment the following percentages of original cost were taken as the costs of maintenance: machinery, one percent; buildings, structures, etc, 0.5 percent; current repair of structures, one percent; equipment, 4.5 percent.

When the dock participates in hoisting ships of 4,000 tons' displacement onto the bank (three dock-places) the number of hoistings per dock increases from 50 to 142 per year, while the cost of hoisting and lowering by the dock drops from 9,000 rubles to 4,500, and to 6,500 including the cost of placing the ship on the bank. The cost of docking a ship for capital repairs lasting 45 days equals 50,000 rubles for a floating dock and 28,000 rubles for hoisting the ship by the dock together with placing it on trucks on the shore.

These data confirm the economic efficiency of using combined ship-hoisting equipment with small changes in the water level and with difficulties in the construction of the underwater portion of the ship-hoisting slip.

The table presented below is a comparison of the costs of placing a single ship in a ship-hoisting structure (hoisting and lowering the ship and keeping it under repair for 10 days) for a maritime ship weighing 1,000 tons:

Type of Ship-Hoisting Equipment	Cost (rubles)
Dry dock for one ship	31,000
Linear slipway	18,000
Transverse slipway	12,000
Floating metal dock	14,000
Slip with 10 places	5,800

The equipment adopted for river ship-hoisting slips makes it possible to standardize their basic elements and to organize their serial production.

A single hoistway with two standard dimensions has been adopted as a standardized element for a ship-hoisting slip. The dimensions of the equipment, the number of hoistways, and the depth at the entrance are determined by the weight, length, and degree of immersion of ships used in calculation.

Use may be made of new structures in the following sequence: initially as a slipway (a single inclined portion) with subsequent development into a two-part slip. The basic data on standard transverse slips and slipways are presented in Table 37.

Box-type floating docks should be used only by enterprises which repair wooden barges. Dry docks and lock-type docks may be used by river installations only when the water level is constant (on weir-controlled rivers) under special conditions which considerably reduce the cost of the structures.

After selecting the type of ship-hoisting structure it is necessary to make a careful determination of its basic dimensions in order to meet the requirements for hoisting all types of ships prescribed in the enterprise plan. The adoption of a solution without sufficient analysis of the maximum dimensions of structures in terms of the maximum permissible size of ships may cause unnecessary increases in the cost of ship-hoisting equipment.

One of the decisive elements of any ship-hoisting structure is the length along the keel blocks. Therefore the first act should be to determine the length of all the ships assigned to the ship-repair enterprise, as shown in Figure 62. This diagram shows that for purposes of calculation a self-propelled ship 85 meters long should be adopted, since there are no longer self-propelled ships and only a small number of non-self-propelled ships whose length varies in a broad range from 90 to 125 meters.

Then a so-called point diagram is constructed of the width of the ships assigned to the ship-repair enterprise as a function of their length and degree of immersion. Analyzing the distribution of points on the diagrams one may determine which self-propelled ships, few in number but determining the limiting size of the slip, should be eliminated and sent to another enterprise. If the width, length, and degree of immersion of individual ships considerably exceed the dimensions of the others these individual ships should be eliminated from the calculation.

The point diagram shown in Figure 63, of the weight (displacement) of ships as a function of their length, provides a solution in which three self-propelled ships should be sent to another ship-hoisting structure, since three points on the diagram are beyond the limits of 500-600 tons of weight, while none of the other ships exceeds this value.

If among the ships used for calculation there is a short ship with considerable weight and degree of immersion it obviously cannot be used on the slip being designed since its weight is concentrated in a small length which makes a specific loading per "pog." meter of length considerably exceeding the loading of other ships in the calculation program.

The representation in the form of a system of points of the basic elements of ships in the calculation program as a function of their length makes it possible to adopt an optimum solution which eliminates a number of ships from the calculation program of the ship-repair enterprise or from the design of ship-hoisting equipment of two types: a ship-hoisting slip for the overwhelming majority of ships and a single floating wooden dock. The latter should provide for repairing ships with maximum basic elements, varying within a wide range, i.e., the maximum suitable for repair in the floating dock. The final solution may be adopted only after working out the design problem with two variations of the selection of ship-hoisting equipment.

Table 36

Mean Calculated Time of Ships in Dock during Repair [in days?]

Type of Ship	Time in Dock for Repairs Capital	Medium	Current
Maritime Ships			
Cargo-passenger, up to 100 meters long	45	20	6
Cargo-passenger, over 100 meters long	55	28	8
Dry-cargo, up to 100 meters long	40	15	4
Dry-cargo, over 100 meters long	45	20	6
Tankers, up to 100 meters long	45	20	5
Tankers, over 100 meters long	50	25	8
Icebreakers, up to 70 meters long	45	25	8
Icebreakers, over 70 meters long	55	28	10
Tugs, up to 1,000 horsepower	35	12	3
Tugs, over 1,000 horsepower	40	15	5
Non-self-propelled metal ships, up to 60 meters long	25	10	4
Non-self-propelled metal ships, over 60 meters long	35	12	5
Scows	45	15	5
River Ships			
Cargo-passenger	55	20	5
Self-propelled cargo	45	15	--
Paddle-wheel tugs	40	10	--
Screw-type tugs	40	12	--
Dry-cargo barges	35	12	--
Tank barges	40	15	--
Wooden barges	35	10	3
Scows	40	15	5

Table 37

Basic Data on Standard Transverse Slips and Slipways

Basic Data on Ship-hoisting Structures	Standard Dimensions of Equipment I	II
Calculation load capacity of pillars, in tons	150	200
Calculation load on pillar roll (mean), in tons	1[illegible]	16.0
Load-lifting capacity of dockyard trucks (for the slip), in tons	60	80
Tractive force of windlass (with pulley, in first case)	15	20

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CHAPTER XXIII

ECONOMIC PORTION OF THE DESIGN

SECTION 94. BASIC CONSIDERATIONS Pages 434-468

An important part of the planning of the construction or reconstruction of a ship-repair or shipbuilding enterprise is to use a definite system of calculation and technical-economic indexes to check the progressiveness of technical norms for the utilization of the enterprise's production resources (productive area, equipment, manpower, and material and power resources) adopted in working out the design, and the general economic efficiency of the planned installation.

All of these problems are solved in the economic portion of the design. The economic portion of the design of a ship-repair or a shipbuilding enterprise includes, by sections and service groups:

(a) Design calculations of the costs of production using specifications for the expenditure of materials in goods and monetary units, calculation of the number of manpower, the wage fund, and estimates of section expenses;

(b) A table of capital investments for basic purposes (buildings, structures, transport equipment, inventory, etc);

(c) Technical-economic indexes.

For the enterprise as a whole:

(a) Economic records, including the enterprise program expressed in goods units and in wholesale prices, the combined specifications for materials consumption, a calculation of the number of personnel and of the wage fund, an estimate of plant-wide expenses, a summation of expenditures for production, and calculations of the costs of commercial production to be turned out by the enterprise;

(b) A combined estimate of expenses for the construction or the reconstruction of the enterprise.

(c) Technical-economic indexes characterizing the level of organization and technology of production and the efficiency of planned construction.

Methodologically it is very important to work out the economic portion of the design simultaneously with the technological and structural parts. The section design calculations and technical-economic indexes make it possible to determine whether the technological solutions adopted in designing individual sections and divisions of enterprises are rational and efficient. The calculations of production costs and the technical-economic indexes by individual sections, divisions, and structures must therefore be worked out and analyzed simultaneously with the technological portion before the section design is completed. Then the designers (specialists in individual parts of the enterprise design) and the chief design engineer may, if necessary, on the basis of an analysis of economic data, check to see whether technical solutions have been adopted which provide for more efficient economic indexes for individual sections, divisions, and for the enterprise as a whole.

The basic question which must be dealt with in the economic portion of the design is the effectiveness of planned capital investments, i.e., the economic purposefulness of construction or reconstruction of the planned enterprise.

The resultant indexes, which characterize the economic purposefulness of construction or reconstruction of a shipbuilding or ship-repair enterprise, are:

(a) The volume of capital investment;

(b) The cost of ship repair and ship construction;

(c) Labor productivity;

(d) The length of the production cycle for all types of repair of maritime ships and capital repair of river ships, as well as of dock (slip) repair of river ships during the navigation season.

The scope of capital investments is shown by the index of total production in wholesale prices per ruble of basic resources.

In addition, a very important factor in evaluating the effectiveness of capital investments is the index of reduction in ship down-time during repairs in comparison with analogous enterprises; this is particularly important for down-time for ships undergoing capital repair. Accelerating the repair of the fleet will increase its operational efficiency, reduce the demand for capital investments in the construction of new ships, and will substantially improve the operating indexes of each transport enterprise.

The overall index characterizing the technical efficiency and level of operations of an enterprise, in terms of production, labor productivity, and economy of materials and other production resources, is the cost of production.

Reductions in the costs of production of very laborious ship-repair operations, and of shipbuilding, are provided for through increases in labor productivity resulting from the mechanization of laborious manual production and hoisting-transporting operations, by the use of progressive technological processes, by the introduction of the elements of assembly-line production in individual areas, by the selection of rational technological methods of ship repair and construction, and by other methods. All of this promotes the development of progressive socialist forms of labor and the achievement of high indexes of equipment utilization.

Reductions in production costs are also brought about through the introduction of progressive norms for the consumption of materials, fuels, and power as a result of their rational utilization, reductions in waste and loss, replacing expensive materials with cheaper ones, reducing amounts of material rejected, and rational organization of production coordination and material-technical supplies. An important factor in reducing production costs is the selection of rational forms of administration, and servicing the sections, divisions, and the enterprise as a whole while still observing strict economies and eliminating superfluities in personnel and other areas.

Minimizing the sum of capital investments made at any one time is an important means of lowering costs through reducing the amount of amortization write-offs.

Conclusions as to the economic efficiency of a planned project can be drawn by comparing the data on the economic portion of the design, calculations, and technical-economic indexes with corresponding indexes for analogous enterprises. For such a comparison the economic indexes of the design must be worked out in harmony with existing portions of the TsSU [Central Statistical Administration?] of the Council of Ministers USSR, the Gosplan [State Plan], the ministries of the maritime and river fleets, and other ministries, according to the method for compiling plans and reports of industrial enterprises.

SECTION 95. COMPILATION OF ESTIMATES OF PRODUCTION WASTE, AND CALCULATIONS OF COSTS.

The goods indexes (consumption of material, labor, and other resources in execution of the production program) worked out in the technological portion of the design should be evaluated in the economic portion in such units that all the various elements in the production process can be added up. An evaluation of the goods indexes of the design, expressed in monetary units, is an example of such a universal measure. Adding up the enterprise's individual

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expenses connected with preparing production will show the cost of production. Thus the cost of production includes, in monetary form, all expenses directly or indirectly connected with preparing production.

A distinction is made among section, installation, and complete (commercial) costs of production. Section production costs are determined by the expenses connected with the operation of the particular section. Installation costs of production include all section costs plus installation-wide expenditures. The complete cost of production is composed of the plant costs and nonproduction (extra-installation) expenses.

All the expenses making up the cost of production of an enterprise are grouped according to their primary elements and expense items. Primary elements are those expenditures which, within a single enterprise, cannot be broken down further into their component elements.

Production costs consist of the following primary elements:

1. Materials (basic and auxiliary), purchased parts, and semifinished products;

2. Contractual deliveries;

3. Fuels;

4. Electric power obtained from outside;

5. Wages (basic and supplementary) of all personnel;

6. Charges to wages;

7. Amortization;

8. Miscellaneous monetary expenses.

An estimate of expenses for production, which includes a total of all enterprise expenses connected with its productive operations, thus determining in the final analysis the costs of overall and commercial production, is compiled from primary expense elements.

Section and installation-wide calculations are made to determine the costs of individual types of parts, semifinished products, and services, and estimated expenses for production.

The primary expense elements, depending on their connection with the production process (their economic content), are combined, in the calculation, with the expense items. All expense items in the calculation are subdivided, on the one hand, into basic or production expenses directly connected with the preparation of production, and, on the other hand, expenses for administration and servicing of production (overhead expenses).

Unlike the items of the production estimate, each of which contains only one primary expense element, most of the expense items in the calculations are complex, i.e., they consist of all or some of the primary elements enumerated above.

Depending on the method of relating them to individual types of production, expenses are divided into direct (immediately related to the cost of an individual type of part) and indirect (divided over the cost of various types of parts).

If the method of compiling a production estimate, specifically that based on the list of primary elements, is the only one used by the enterprises in all branches of USSR industry, the structure of the calculation sheet (expense items) and the methods of determining the indirect expenses among individual types of parts are different in different operations and branches of industry.

The industrial enterprises under the ministries of the maritime and river fleets have a method of breaking down the indirect expenses (section, installation-wide, and others) proportional to the sum of the basic production wage of workers based on the wage scale (without extra payments).

In calculations of shipbuilding and repair, machine-building parts, and other industrial production of ship-repair and shipbuilding enterprises under the ministries of the maritime and river fleets, expenses for production are grouped according to the following expense items:

1. Materials (according to the established list);
2. Cost of waste (subtracted);
3. Semifinished products made by the enterprise;
4. Contractual deliveries;
5. Contractual labor;
6. Deck and technical equipment (excluding items for housing purposes in ship repair);
7. Basic wage of production workers based on the wage scale (tariff fund);
8. Additions to the tariff fund;
9. Supplementary wages of production workers;
10. Total of basic and supplementary wages of production workers;
11. Charges to the wage fund;
12. Section expenses;
13. Installation-wide expenses;
14. Special expenses;
15. Extra-installation (nonproduction) expenses;
16. Complete cost.

In order to compile design calculations and a production estimate according to a method identical or similar to that used in practice for ship-repair and shipbuilding operations, goods indexes of the technological portion of the design must be worked out and grouped, taking into account the requirements of this method.

Below are given the characteristics of individual expense items, methodological indications of the order in which they are to be determined and evaluated in monetary terms, and their relationships to production costs.

Material Expenses

The following items are the basis for working out the volume of material expenses in compiling costs:

1. The specifications for expenditure of basic and auxiliary materials and purchased semifinished products, information on contractual deliveries, ship equipment, and fuel, worked out in the technological portion of the design by individual sections and installation-wide divisions;

2. Prices of prepaid storage for the planned enterprise.

In the expense specifications materials are grouped according to current standard items, with the exception of material used to service operations: their cost is included in section and installation-wide expenses.

The price for prepaid storage for an enterprise is established on the basis of a special calculation and includes:

(a) The cost of materials, equipment, and ship fittings according to wholesale supplier prices (according to price list);

(b) Transport wages (transport tariffs) together with all supplementary fees;

(c) Enterprise expenses for loading, unloading, and placing in warehouses;

(d) Payments to supply organizations.

Semifinished products manufactured by the enterprise itself -- steel, cast-iron, and nonferrous castings, forgings, lumber, etc --

are included in the costs of commercial production according to the cost established in the corresponding design calculations. As a supplement to the economic records summary specifications are given of the consumption of materials, purchased semifinished products, parts, and contractual supplies, in goods and monetary units, showing their breakdown by delivery regions.

The data on supply regions make it possible to determine the purposefulness of the planned branch and inter-branch coordination. In addition they provide a basis for solving the problem of the scope of expense for transport tariffs in the total of prepared storage fees by individual groups of materials, equipment, parts, and fuel.

<u>Number of Personnel and Wage Fund</u>

In the technological portion of the design the personnel of the sections, auxiliary divisions, and installation-wide services are divided into the following categories: workers, engineering-technical workers (ITR), service personnel, younger service personnel (MOP), guards, and apprentices.

Depending on the functions performed in the production process of any given enterprise the workers are divided into basic (productive) and auxiliary.

Basic workers include those in the basic production sections (machine-tool, assembly, and preparatory) directly occupied in preparing the enterprise's basic industrial production.

Auxiliary workers are those in the basic sections occupied in secondary operations (repair, transport, etc) and all workers in the auxiliary sections and installation-wide divisions occupied in basic and secondary work.

The wage fund is the sum necessary to pay the enterprise personnel for a definite period of time (the year, quarter, month).

The planned wage fund of the workers includes:

1. The tariff wage fund, i.e., the wages paid for time worked according to hourly and piecework tariff rates;

2. Legally prescribed overtime and supplementary payments in addition to the tariff wage fund. The tariff wage fund, together with overtime and supplementary payments, comprises the basic wage fund. Overtime and supplementary payments include payments to piecework workers according to the sliding scale, bonuses to hourly workers, etc.

3. Supplementary wages, including payments for basic and supplementary vacations, for the performance of social and state obligations, for the time necessary to travel to vacation places and back, and payments to workers in remote locations (the Far North, etc).

Planned wage funds for engineering-technical workers, service personnel, younger service personnel, and guards, over and above the official wages paid, include supplementary payments for working in remote locations (the Far North), for longevity, and bonuses for plan fulfillment. On the basis of the labor content of the production program, the administrative system adopted, and the servicing of production, calculation information is compiled on the number of personnel and the wage fund of the planned enterprise.

The information on the number of personnel in the individual sections and divisions, which is the starting data for calculating the wages and the plan for preparing and filling out the cadres, must be worked out by groups of occupations and the mean category for each group.

The number of production and auxiliary workers occupied in performing basic operations in the auxiliary sections is determined by dividing the labor content of the production program by the annual time fund per worker as established in the plan.

The numbers of productive workers in the basic and auxiliary sections, engineering-technical workers, service personnel, younger service personnel, and guards are determined from the breakdown of operations according to technical service norms existing in the planned organization.

The method of calculation in the plan for the wage fund of productive and auxiliary workers occupied in performing the basic operations in auxiliary sections differs somewhat from the method usual in planning. The difference is associated with the fact that the labor content of the production program in the plan is determined not from output norms existing in the given branch of industry but according to progressive technical norms. In this connection, in determining the wage fund in the plan, the hourly rate for category I should be established not according to the tariff but by calculation.

The calculation hourly wage of workers includes, in addition to the hourly rate for piecework workers [sic], an additional payment according to estimates of overfulfillment of existing output norms.

For the planned enterprise the calculation time rate for category I is established from studies of the report data of existing enterprises analogous to the planned enterprise.

The wage fund of productive workers, and of auxiliary piecework workers, occupied in performing basic operations in the auxiliary sections and installation-wide divisions is calculated approximately according to the following scheme:

1. Name of section and installation-wide division

2. Labor content of production program, in thousands of man-hours

3. Mean tariff category

4. Mean tariff coefficient

5. Hourly calculation rate for a piecework worker [sic] of category I (with bonuses) in rubles

6. Hourly calculation rate for a piecework worker [sic] in the mean category, in rubles

7. Wage fund of a productive worker according to calculation rates for the production program, in thousands of rubles

Overtime and supplementary payments in addition to the wage fund, according to calculation rates

8. In percent

9. In thousands of rubles

10. Basic wage fund of productive workers, in thousands of rubles

Supplementary wages

11. In percent of the basic wage

12. In thousands of rubles

13. Wage fund (basic and supplementary), in thousands of rubles

14. Annual time fund per worker, in man-hours

15. Mean annual number of production workers

16. Mean wage per production worker

For the other categories of enterprise personnel there is no practical need to separate basic and supplementary wages, and the wage fund may be calculated on the basis of official information and payments, including supplementary payments for longevity, for working in remote locations, and bonuses for plan fulfillment.

In the summary estimate of expenses for the operation of the planned enterprise the wage funds (basic and supplementary) of all categories of personnel are combined in a single item -- the wages (basic and supplementary).

In the section and installation-wide calculations the wage fund of productive workers refers to basic (productive) expenses, broken down into basic and supplementary wages. The wages of auxiliary workers and other categories of personnel refer to section and installation-wide expenses.

Calculations of wages include deductions made to organs of social feeding equal to 6.7 percent of the total wage fund.

The estimate of production expenses and the calculations of costs include wage items according to the above breakdown of the wage fund.

Special Expenses

The calculation item entitled "Special Expenses" of ship-repair and shipbuilding operations includes expenses for the preparation and beginning of production, for meeting the cost of templets, tools, and attachments, compiling and expert treatment of plans and estimates, observation of the USSR Registry for shipbuilding, machine-building, medium, capital, and restorative repairs of ships, the use of ship-hoisting equipment and floating cranes, leased tugs, etc.

Some of these expenses (preparation of templets and tools, the use of ship-hoisting equipment, etc) refer to the services of corresponding auxiliary sections and, in the breakdown, are included under the item "Special Expenses" in the calculations of individual types of operations and parts. Concerning other special expenses not connected with the functioning of individual sections (compiling and expert handling of plans and estimates, observing the USSR Registry, etc), a separate estimate is compiled with subsequent breakdown of these expenses in the installation-wide calculations.

Expenses for the Servicing and Administration of Operations

This category of operational expenditures includes section and installation-wide expenses. Section expenses include those connected with the administration, servicing, and safety of section operations. Below is a list of items in the section expenses of ship-repair and shipbuilding enterprises serving the maritime and river fleet:

1. Material for general operational purposes.
2. Fuel, power, and water for general operational purposes.
3. Basic and supplementary wages.
4. Items in the wage fund.
5. Expenses for labor safety.
6. Maintenance of buildings, structures, and inventory.
7. Maintenance of equipment.
8. Wear, repair, and restoration of low-priced tools, attachments, and division inventory.
9. Current repair.
10. Maintenance of section laboratories and expenditures for rationalization, experimentation, and research.
11. Maintenance of section transport.
12. Amortization.

Installation-wide expenses are those necessary for the installation administrative personnel, for dispatching, service travel, rationalization, invention, labor safety, office expenses, postal and telegraph expenses, etc.

The totals for estimates of section and installation-wide expenditures are determined by calculation of their individual items.

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An important position in these estimates is occupied by services of auxiliary sections and installation-wide divisions (supplying steam, electric power, water, and compressed air; repairing installation equipment, etc). The expenses are established by breaking down these services among the consuming sections.

The wage fund of auxiliary workers and other personnel (engineering-technical workers, etc) is determined from calculation information of the corresponding sections and installation-wide personnel.

Amortization write-offs are determined from the cost of basic section resources and existing norms.

The amount of basic section resources is determined by the cost of:

(a) Buildings, structures, and special fittings from the data on construction estimates;

(b) Equipment from the information on equipment, showing its full cost including payments to suppliers for equipment according to price lists, transport expenses, payments of sales organizations, and expenses for foundations (according to estimates), installation, and fittings;

(c) Tools and inventory, equal to 2 and 2.5 percent, respectively, of the cost of equipment, if this has not been included in the equipment information.

The following norms are used to determine the total of amortization write-offs; stone buildings, 2.5 percent; wooden buildings, 6.3 percent; hydraulic-engineering structures, 2 percent; equipment, 5-6 percent; tools and inventory, 10 percent.

From other items of overhead expense (tool wear, labor safety, dispatching expenses, etc) expenditures are established according to norms worked out by the planning organization in terms of definite indexes (number of personnel, wage fund, cost of tools, etc).

Section expenses are broken down among costs of individual types of work and parts proportional to the expenditures for wages to prepare a given part or to perform a definite type of work.

Section overhead expenses as a percentage of wages are determined from the following expression:

$$k = \frac{T \cdot 100}{F_3} \qquad (115)$$

where k = the percentage of section expenses;

T = the total estimates of section expenses; and

F_3 = the tariff wage fund for productive workers.

Installation-wide expenses as a percent of the tariff wage fund for productive workers are established once for the enterprise and are determined from the following expression:

$$k_1 = \frac{T_o \cdot 100}{F_3} \qquad (116)$$

where k_1 = the percentage of installation-wide expenses;

T_o = total estimates of section-wide expenses; and

F_3 = the tariff wage fund for productive workers throughout the enterprise.

Nonproductive Expenses

Nonproductive expenses include expenditures of the enterprise on write-offs for research, norm-setting, experimental work, standardization, and the maintenance of the superior khozraschet organization (the steamship comparny, trust). In cost calculations these expenses are broken down in proportion to all installation costs.

The development of cost indexes should begin with compiling estimates of production expenditures and a determination of the cost of services of the installation-wide divisions and auxiliary sections.

The total of expenditures and the cost per unit production of installation-wide divisions (transmission of electric power, steam, oxygen, and compressed air; transport services, etc) can be determined in a single calculation table according to the sample scheme shown in Table 101.

Table 101

Calculation Table for Determining Expenditures and the Cost per Unit Production of an Installation-Wide Division

Items of Production Expense	Units	Quantity	Unit Price (In Rubles)	Total Expenses (1,000 Rubles)	Basis for Determining Expenses
[1]	[2]	[3]	[4]	[5]	[6]
I. Primary Expenses Caused Directly by the Division:					
Total material expenses					Specifications of material expenses No...
Wages of workers in basic operations					Number of personnel and wage fund No...
(a) According to tariff					The same
(b) Overtime and supplementary payments in addition to tariff wage fund					The same
(c) Supplementary wages					The same
Wages of service and administrative personnel					The same
Additions to wage fund					6-7 percent
Amortization					Basic resources No...
Miscellaneous monetary expenses					Estimate No...
Total for Group I					
II. Complex Expenses for Services of Other Sections and Divisions:					
Electricity for power					Power-station estimate

[continued]

[Table 101, continued]

[1]	[2]	[3]	[4]	[5]	[6]
Electricity for illumination					The same
Interior heating					Boiler estimate No...
Current repairs					
(a) Equipment					Estimate of repair Section No...
(b) Tools, attachments, etc					Estimate of tool section No...
Total for Group II					
Total Expenses					
Cost (per unit production)	--			--	
Breakdown of production (expenses) of installation-wide divisions by consumers:					
1. Enterprise sections and divisions:					
(a) Mechanical					
(b) Hull-and-boiler					
(c) Oxygen station					
etc.					
I. Side Income (commercial production):					
Total					

On the basis of the breakdown of services by consuming sections, of the specifications for materials consumption, purchased semifinished products, contractual deliveries, and of information on the number of personnel and the wage funds, estimates are compiled of operational expenses and section expenditures of the basic sections, as well as calculations of section costs by types of work and parts. Cost indexes are worked out by compiling a summary of operational expenditures and installation-wide calculations of operating costs.

Cost tables and calculations are compiled in terms of actual costs under the technical industrial finance plan, with changes and additions resulting from individual features of the planned enterprise.

The tables of estimated section, installation-wide, and special expenses for the sections and divisions should, when the expenses for operations of the planned enterprise are added up, show:

1. Total intra-installation turnover and the installation cost of total (commercial) operations;

2. A breakdown of installation costs for (total) commercial production into primary expense elements.

An alternative scheme for summarizing operating expenses is shown in Table 102.

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Table 102

Summary of Operational Expenses of a Shipbuilding Installation (In Thousands of Rubles)

[First Vertical Page]

Productive Portion of Installation	[1]	[2]	[3]	[4]	[5]	[6]
I. Processing Assembly Sections						
1. Hull preparing	1,437.8	11.3	50.0	865.0	416.3	222.9
2. Assembly and welding	30.0	20.0	50.0	1,104.9	659.1	195.8
3. Ship-assembly	1,069.2	1.7	65.0	2,622.9	1,686.9	368.9
4. Woodworking	199.1	--	5.5	330.8	226.1	41.3
5. Mechanical	1,010.9	1.4	42.9	1,397.3	851.6	217.0
6. Pipeline	183.7	2.5	3.1	245.8	152.1	28.6
7. Electroplating	5.9	--	11.2	99.1	59.7	10.9
8. Delivery	--	--	1.0	128.1	97.0	--
Total	3,936.6	36.9	228.7	6,843.9	4,148.8	1,085.4
II. Preparatory Sections						
1. Casting	344.1	14.3	30.0	332.7	160.5	81.9
2. Forging	168.6	9.7	11.0	346.2	204.6	55.7
3. Sawing	210.0	--	14.0	242.9	130.0	59.8
4. Electrode shop	43.9	--	4.5	54.4	25.9	13.9
Total	766.6	24.0	59.5	976.2	521.0	211.3
III. Auxiliary Sections and Installation-Wide Divisions						
1. Repair	81.2	--	21.5	845.4	550.1	88.6
2. Tool	12.4	--	28.0	649.5	407.5	63.0
3. Electrical repair	144.1	5.0	5.8	201.0	126.9	17.0
4. Heating boiler room	24.0	240.0	26.0	218.6	126.9	61.9
5. Compressor station	--	--	40.0	33.0	29.9	--
6. Oxygen station	--	--	31.2	57.3	23.8	18.6
7. Acetylene station	23.2	--	--	17.5	15.9	--
8. Transport section	--	--	9.5	1,265.2	1,030.1	52.3
Total	284.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[continued]

[Table 102, First Vertical Page, continued]

Productive Portion of Installation	[1]	[2]	[3]	[4]	[5]	[6]
IV. Installation-Wide Administration and Services	10.0	8.0	22.2	2,139.9	272.9	92.9
Total of operating expenses, including intra-installation turnover (total turnover)	4,998.1	313.9	472.4	13,247.6	7,253.6	1,691.0

[Table 102, continued, Second Vertical Page]

[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]
54.3	693.5	92.2	65.6	13.7	55.7	232.8	26.0	2,678.6
75.2	930.1	115.2	45.9	13.7	71.2	232.8	14.6	1,523.5
182.7	2,238.5	276.4	85.2	22.8	169.0	232.7	41.0	4,201.5
21.1	288.5	57.0	26.2	9.1	24.6	19.7	6.2	635.9
93.1	1,161.7	149.8	72.1	13.7	90.0	145.2	26.4	2,714.1
14.8	195.5	34.6	6.6	9.1	15.8	24.0	4.7	479.6
5.8	76.4	11.5	6.6	4.6	6.4	24.0	1.4	148.0
8.0	105.0	23.1	--	--	8.2	13.2	1.5	152.0
455.0	5,689.2	759.8	308.2	86.7	440.9	924.4	121.8	12,533.2
19.9	262.3	46.1	19.7	4.6	21.4	8.8	7.2	758.5
22.1	232.4	46.1	13.1	4.6	22.3	24.0	5.7	587.5
17.0	206.8	23.0	13.1	--	15.6	17.8	4.9	505.2
3.1	42.9	11.5	--	--	3.5	6.0	1.1	113.4
62.1	794.4	126.7	45.9	9.2	62.8	56.6	18.9	1,964.6
54.7	693.4	103.7	39.3	9.1	54.5	29.4	10.1	1,042.2
37.9	508.4	103.7	32.8	4.6	41.8	86.6	7.9	826.2
11.4	155.3	34.6	6.5	4.6	13.0	24.0	3.9	396.8
18.3	207.1	11.5	--	--	14.1	84.1	5.8	612.6
3.1	33.0	--	--	--	2.1	7.5	0.4	83.0
3.4	45.8	11.5	--	--	3.7	9.0	0.7	101.9
1.6	17.5	--	---	--	1.1	0.8	0.4	43.0
106.0	1,188.4	34.6	19.4	22.8	81.4	124.4	14.7	1,495.2
236.4	2,848.9	299.6	98.0	41.1	211.7	365.8	43.9	4,600.9

[continued]

[Table 102, Second Vertical Page, continued]

[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]
22.0	337.8	832.1	451.0	469.6	138.0	472.5	27.7	2,818.3
775.5	9,720.3	2,018.2	983.1	606.8	853.4	1,819.3	212.3	21,917.0

[Table 102, continued, Third Vertical Page]

[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]
--	--	--	30.5	--	30.5	150.0	70.0	50.0
--	--	--	--	84.4	84.4	150.0	70.0	50.0
--	--	--	45.2	42.3	87.5	150.0	70.0	30.0
--	--	--	411.0	--	411.0	150.0	113.6	20.0
540.0	269.7	615.0	--	1.6	1,426.3	150.0	400.0	150.8
--	--	--	--	3.0	3.0	125.0	40.0	11.0
--	--	--	--	--	--	89.0	10.0	50.0
--	--	--	--	--	--	5.2	3.0	--
540.0	269.7	615.0	486.7	131.3	2,042.7	969.2	776.6	361.8
--	--	--	--	2.1	2.1	30.0	10.0	10.0
--	--	--	--	--	--	20.0	10.0	5.0
--	--	--	--	--	--	10.0	1.0	3.0
--	--	--	--	--	--	5.0	3.0	5.0
--	--	--	--	2.1	2.1	65.0	24.0	23.0
50.8	37.4	49.3	61.3	--	198.8	--	100.0	40.0
5.2	0.8	19.6	--	--	25.6	100.0	--	8.0
--	--	--	--	--	--	50.0	10.0	--
--	--	--	--	--	--	50.0	10.0	10.0
--	--	--	--	--	--	20.0	--	8.2
	--	--	--	--	--	25.0	--	15.0
--	--	--	--	--	--	5.0	--	5.0
--	--	--	--	--	--	100.0	60.0	3.0
56.0	38.2	68.9	61.3	--	224.4	350.0	180.0	89.2

[continued]

[Table 102, Third Vertical Page, continued]

[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]
--	--	--	--	--	--	20.0	--	--
596.0	307.9	683.9	543.0	133.4	2,269.2	1,404.2	980.6	474.0

[Table 102, continued, Fourth Vertical Page]

[25]	[26]	[27]	[28]	[29]	[30]	[31]	[32]	[33]
150.0	--	91.0	37.4	200.0	743.4	3,457.5	322.0	3,779.5
150.0	22.0	--	--	180.0	622.0	2,230.7	514.0	2,744.7
150.0	75.5	41.0	18.2	500.0	1,032.7	5,321.7	1,304.7	6,626.4
40.0	--	--	--	110.0	433.5	1,480.5	176.0	1,655.5
60.0	5.3	--	--	65.0	831.1	4,971.5	660.0	5,631.5
50.0	1.4	--	--	17.0	244.4	727.0	119.0	846.0
50.0	--	--	--	2.4	201.4	349.4	46.0	395.4
2.8	--	--	--	--	11.0	163.0	75.0	238.0
652.8	105.0	132.0	53.6	1,074.4	4,125.4	18,701.3	3,215.7	21,917.0
--	9.8	12.8	0.7	70.0	143.3	903.9	--	--
23.0	--	2.7	0.7	35.0	96.4	683.9	--	--
18.8	--	--	--	10.0	42.8	548.0	--	--
3.0	--	--	--	4.0	20.0	133.4	--	--
44.8	9.8	15.5	1.4	119.0	302.5	2,269.2	--	--
5.0	0.4	--	--	17.8	163.2	1,404.2	--	--
15.0	0.8	--	--	5.0	128.8	980.6	--	--
15.0	0.2	--	--	2.0	77.2	474.0	--	--
--	--	--	--	150.0	220.0	832.6	--	--
--	--	--	--	5.0	33.2	116.2	--	--
--	--	--	--	5.6	45.6	147.5	--	--
--	--	--	--	2.0	12.0	55.0	--	--
--	--	--	--	--	163.0	1,658.2	--	--
35.0	1.4	--	--	187.4	843.0	5,668.3	--	--

[continued]

[Table 103, Fourth Vertical Page, continued]

[25]	[26]	[27]	[28]	[29]	[30]	[31]	[32]	[33]
100.0	--	--	--	277.4	397.4	3,215.7	--	--
832.6	116.2	147.5	55.0	1,658.2	5,668.3	29,855.1	--	--

Key to Headings

Primary Cost Elements

[1] Material and Purchased Semifinished Parts

[2] Fuel

[3] Purchased Electric Power

Wages (Basic and Supplementary)

[4] Total

Workers

Basic

[5] On Basic Production Operations

[6] On Auxiliary Operations

[7] Supplementary

[8] Total

[9] Engineering-Technical Workers

[10] Service Personnel

[11] Younger Service Personnel

[12] Charges to Wages

[13] Amortization

[14] Miscellaneous Monetary Expenses

[15] Total

Complex Expense Items

Semifinished Products

[16] Iron Castings

[17] Nonferrous Castings

[18] Forgings

[19] Lumber

[20] Electrodes

[21] Total

Services of Auxiliary Sections and Installation-Wide Divisions

[22] Repair

[continued]

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[23] Tool

[24] Electrical Repair

[25] Heating and Boiler Room

[26] Compressor Station

[27] Oxygen Station

[28] Acetylene Station

[29] Transport Section

[30] Total

[31] Total Expenses by Sections (Without breakdown of installation-wide expenses by sections)

[32] Installation-Wide Expenses (Breakdown by sections)

[33] Total Production Cost for Installation

In the summary calculation of total and commercial operating expenses a distinction is made between basic and overhead expenses, depending on their economic content (expense items). These data are included among the indexes of the economic effectiveness of the planned project.

Of importance in the economic portion of the design, in addition to the cost of total (commercial) production, is the index of total (commercial) production evaluated in current and fixed wholesale prices. At the present time the fixed wholesale prices without turnover assessments, for industry, are those effective as of 1 January 1952.

A comparison of commercial production in current wholesale prices with production costs makes it possible to determine accumulation and the profitability of enterprise operations. Such indexes as the output per worker, production per ruble of basic funds, and others are determined from the cost of total production in fixed wholesale prices.

Total production in wholesale prices is determined by evaluating the quantitative production output in the existing variety, in current and fixed wholesale prices. Only such a method of evaluating production makes it possible to obtain reliable indexes for comparison with existing enterprises and for determining the economic advantages of the plan.

For shipbuilding and machine-building operations wholesale prices are taken from the price lists of the Ministry as of 1 January 1952 and from current lists. For ship-repair production fixed wholesale prices are determined by evaluating the operations shown in standard repair reports for individual machinery and hull centers and repair categories adopted for working out the technological portion of the plan, based on wholesale prices from the 1952 price lists. In converting to current wholesale prices, the calculated fixed wholesale prices are multiplied by the coefficients of change in wholesale prices in comparison with 1952 as established by the ministries of the maritime and river fleets USSR.

In the absence of wholesale prices for individual types of shipbuilding, machine-building, and ship-repair operations these should be determined in the plan on the basis of existing wholesale prices for parts and operations comparable, in respect to technical nature, with these operations. The method of determining these wholesale prices adopted in the plan should be explained carefully in the economic report.

SECTION 96. CALCULATION OF TECHNICAL-ECONOMIC INDEXES OF SHIPBUILDING AND SHIP-REPAIR ENTERPRISES

The technical-economic indexes of the plan for an industrial enterprise, when compared with report data from an existing enterprise, reflect efficiency and the changes which result from measures envisioned in the plan. The technical-economic indexes of a planned enterprise can be expressed in goods units, monetary value, or abstract units.

For a shipbuilding and ship-repair enterprise, in which complex and varied operations are carried out, goods technical-economic indexes should be worked out, principally for the basic sections; this will make it possible to evaluate the operation of each of them.

Distinctions are made between section and installation-wide, and between qualitative and quantitative, technical-economic indexes.

Quantitative indexes are those showing the scope of basic operating resources (production area, equipment pool, etc), and the scope and resources of production (production output, personnel, wage fund, materials consumption, etc).

Qualitative indexes (labor productivity, cost per unit production, coefficient of mechanization, power supply, etc) characterize the technical-economic efficiency of the planned enterprise and define the relationshipsamong individual quantitative indexes.

In planning, quantitative indexes must be adopted, and their realization assured through a complex of measures in the technology, organization, and economics of production.

Depending on the elements of the production process which they characterize, technical-economic indexes are divided into the following basic groups.

1. Production.
2. Labor.
3. Cost.
4. Basic and turnover resources.

Each branch of industry has a definite group of technical-economic indexes, reflecting the aspects of the particular operation. A list of the basic technical-economic indexes of shipbuilding and ship-repair enterprises is given in Table 103.

Table 103

Basic Technical-Economic Indexes of a Shipbuilding and Ship-Repair Installation

Technical-Economic Data and Indexes [1]	Unit [2]	Indexes of the Planned Enterprise [3]	Indexes of the Enterprise before Reconstruction, or of an Existing Enterprise Analogous with Planned One [4]	Remarks [5]
I. Production				
1. Annual production program, in goods units:				
(a) Shipbuilding: cargo ship (type, capacity)	Units			
(b) Capital repair of ships (list of calculation types)	Units			
(c) Medium repair of ships (list of calculation types)	Units			
(d) Ship machine-building	Units			
(e) Semifinished products made by the enterprise:				
Steel castings	Tons			
Iron castings	Tons			
Forgings	Tons			
Lumber, etc	cu m			
2. Total production in fixed wholesale prices	1,000 rubles			
(a) Enterprise sections:				
Shipbuilding				
Ship repair				

[continued]

[Table 103, continued]

[1]	[2]	[3]	[4]	[5]
Ship machine-building, including production of spare parts for other enterprises				
(c) Contractual deliveries and work				
3. Total labor content of annual production program	Man-hours			
Machine-tool work of mechanical section	Machine-hours			
4. Annual electric-power consumption	1,000 kWh			
5. Output in fixed wholesale prices (the numerator contains the total cost of all production; the denominator that not including contractual deliveries)				The numerator shows total production in fixed wholesale prices or total production without contractual deliveries or work; the denominator contains the number of productive and auxiliary workers, the wage fund (basic and supplementary) of the productive workers, and the cost of industrial-production resources
(a) Per registered worker	Rubles			
(b) Per production worker	Rubles			
(c) Per ruble of production wages	Rubles			
(d) Per ruble of basic resources for production use	Coefficient			
6. Output in goods units per registered worker:				The denominator shows the total number of workers in each section; the numerator contains the quantity of metal worked, the output of castings and forgings, and the lumber processed, respectively
In the hull section (metal)	Tons			
In the casting section (castings)	Tons			
In the forging section (forgings)	Tons			
In the woodworking section (lumber)	cu m			
7. Duration of the construction cycle:	Days			Calculated according to normed graph
(a) For type-A ships				
Dock period				
Fitting-out period				
(b) For type-B ships, etc.				
8. Duration of capital-repair cycle	Days			Calculated according to normed technological graph
(a) For type-A ships, according to normed technological plan				

[continued]

[Table 103, continued]

[1]	[2]	[3]	[4]	[5]
Down-time in dock or slip (of above)				
(b) The same, type B, etc				
II. Labor				
9. Average annual number of registered workers	Men			
(a) Workers:				
Production	Men			
Auxiliary	Men			
Auxiliary as a % of production	%			
(b) Engineering-technical personnel	Men			
As a % of total workers	%			
(c) Service personnel	Men			
As a % of total workers	%			
(d) Younger service personnel	Men			
10. Skills of workers (medium category)	Category			
(a) Of all workers				
(b) Of productive workers				
11. Coefficient of number of shifts	Coefficient			The numerator contains the total number of workers; the denominator the number of workers in the maximum shift
12. Coefficient of mechanization of work	Coefficient			Relationship of labor content of machine-tool and mechanized work to total labor content of production program
13. Power supply (potential) per worker	kWh			The numerator shows installed capacity; the denominator the number of workers on the maximum shift

[continued]

[Table 103, continued]

[1]	[2]	[3]	[4]	[5]
14. Basic industrial-production resources per worker	Rubles			The numerator shows the cost of basic industrial-production resources; the denominator the number of workers on the maximum shift
(a) Total				
(b) Equipment				
15. Mean annual worker's wage	Rubles			The numerator shows the wage fund; the denominator the number of registered personnel
(a) Productive				
(b) Auxiliary				
III. Cost				
16. Total enterprise turnover	1,000 rubles			
17. Installation operating cost	1,000 rubles			
18. Structure of operating expenses, according to calculation list:	%			
(a) Material and purchased semi-finished products and parts				
(b) Contractual deliveries				
(c) Semifinished products made by enterprise				
(d) Wage (basic and supplementary) of productive workers, minus deductions for social feeding				
(e) Special expenses				
(f) Section expenses				
(g) Installation-wide expenses				
Total cost	%			
19. Norm of overhead expenses, over wages of production workers, according to tariff:	%			
(a) Section workers				
(b) Installation-wide workers				
20. Installation cost per unit of basic production				
(a) Shipbuilding	1,000 rubles			

[continued]

[Table 103, continued]

[1]	[2]	[3] [4] [5]
Type-A ship		
Type-B ship		
(b) Machine-building, per unit	Rubles	
21. Section production cost:	Rubles	
(a) Hull section, per ton of metal hull		
(b) Casting section, per ton of useful castings		
(c) Steel foundry		
(d) Iron foundry		
(e) Forge section, per ton of useful forgings		
(f) Woodworking section, per cubic meter of lumber worked, etc		
22. Annual economies resulting from reducing production costs for the enterprise as a whole (for new construction, in comparison with an existing enterprise; and for reconstructed enterprise, including pre-reconstruction period)	1,000 rubles	Determined by comparing calculated cost of the calculation program, based on data from an existing enterprise, with the cost calculated in the design
IV. Basic Production Resources		
23. Total expenses, according to summary estimate	1,000 rubles	
24. Cost of all basic resources Of above, industrial-production resources	1,000 rubles	Minus residence fund and and social-cultural establishments
25. Total volume:	Cu m	
Of productive rooms		
Of secondary rooms		
Of residence fund		
26. Number of dock places by groups:	Units	
(a) Dockyards		

[continued]

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[Table 103, continued]

[1]	[2]	[3]	[4]	[5]
(b) Slips or slipways				
(c) Floating or dry docks				
27. Length of shore equipment	'pog.' meters			
28. Installed capacity	kWh			
29. Period of value of capital expenses for basic industrial-production resources	Years			The numerator shows the sum of capital investment; the denominator the annual economy resulting from cost reduction
V. Turnover Funds				
30. Turnover funds	1,000 rubles			Planned enterprise reserves for all types of material, incompleted production, semifinished products, and finished parts in warehouse
31. Annual turnover rate of turnover funds	Coefficient			The numerator shows commercial (realized) production in current wholesale prices without assessment from turnover; the denominator contains the total of all turnover funds

The technical-economic indexes of a planned enterprise are compared with analogous indexes of existing enterprises in the same branch of industry and with reconstructed enterprises, i.e., with the report indexes achieved before reconstruction. Report technical-economic indexes are established through investigation and study of report material of one or more enterprises taken for comparison.

In order to draw proper conclusions from the comparison of design and report indexes they must be comparable, specifically in relation to the monetary value of individual indexes. For example, for the calculation and the subsequent comparison of the coefficients of output of basic industrial-production resources, the evaluation of basic resources of the existing and planned enterprises must be made in identical prices for construction and fittings. For this purpose the cost of the basic resources of an existing enterprise, based on data concerning its balance-sheet costs, on the intervals at which the basic resources are placed in use, and on data concerning the coefficients of change in the cost of construction work and of fittings, is recalculated according to prices obtaining at the time the plan is compiled. The index of total (commercial) production is made comparable by evaluating the output of the existing and planned enterprises in fixed wholesale prices as of 1 January 1952.

For purposes of calculation in the plan, total production (counting the remaining uncompleted production at the beginning and end of the year as equal) is taken as equal to commercial production.

In reconstructing an installation the design organization should carefully check the productive capacity of the enterprise before reconstruction, based on the calculation program of the design, in order to establish the extent to which increased capacity can be achieved through raising the coefficient of utilization of production resources existing before reconstruction, and the extent through introduction of new productive capacity. Naturally if the coefficient of utilization of productive capacity was low before reconstruction and the enterprise had considerable reserves, then consideration of these reserves in the design should result in a corresponding reduction in the volume of capital investment.

Technical-economic indexes are part of the economic documentation of the design. On the basis of analysis of indexes conclusions are drawn concerning the economic effectiveness of the planned construction or reconstruction or a new or existing enterprise.

The final indexes of these conclusions are the value of capital investment and the coefficient of output of basic industrial-production resources.

The value of capital investment is determined from the formula:

$$t = \frac{K}{E}$$

where K = the total of capital investments for construction or reconstruction;

E = the annual economy resulting from reducing the cost of production in the planned enterprise in comparison with the cost of production in the calculation program, based on data from existing enterprises in this branch of production;

t = the period of value (the number of years).

In calculating the value of ship-repair enterprises, and lacking data for the recalculation of total (commercial) production of the planned enterprise in terms of the cost of o.. existing enterprise, in the denominator of the above formula the total of economies resulting from cost reductions (E) may be replaced by the total accumulation of the planned enterprise. This accumulation is determined as the difference between the cost of production in existing wholesale prices of the planned enterprise and the planned cost.

A supplementary index of the economic effectiveness of a planned enterprise is the reduction in the production cycle, in days of ship repair. A calculation of the economies achieved by reducing the ship down-time during repair can be made from the form given in Table 104.

Table 104

Form for Calculating Reductions in Down-Time in Repairing Maritime Ships

1. Number

[continued]

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[Table 104, continued]

2. Name of standard transport ships in the calculation program

3. Net load capacity per unit, in tons

4. Repair category

5. Number of repairs per year in the calculation program

6. Mean duration of repair before reconstruction, in days

7. Mean duration of repair, based on norm graph, following reconstruction, in days

8. Reduction in repair down-time of ships, in days

9. Cost of maintaining ship during repair, in rubles per day

10. Economies resulting from reductions in down-time during repair, in thousands of rubles

11. Number of ton-days gained from economies

12. Assumed productivity per ton of load capacity, for total operating time

13. Number of ton-miles of possible production during time gained by economies

14. Mean accumulation per ton-mile

15. Economies adding to accumulation, resulting from reduction of down-time in repair

16. Total economies resulting from reduction of down-time in repair

The utilization of basic industrial-production resources of an enterprise is characterized by the coefficient of output, which equals the production output in rubles per ruble of basic industiial-production resources. The scope of this production differs not only for various branches of production but also for enterprises in a single branch, depending on the variety of products turned out (metal self-propelled and non-self-propelled ships, cargo or passenger ships, wooden non-self-propelled ships) and the types of ships repaired (river, maritime). Thus the coefficient of output of shipbuilding enterprises is considerably higher than that of ship-repair enterprises. In the case of enterprises which repair maritime ships, the index of output will be lower than that of enterprises which repair river ships, because of the considerable extra capital investments necessary for ship-hoisting equipment, shore structures, and fencing.

In the final conclusions concerning the usefulness of construction or reconstruction of an installation, account should be taken not only of the economic effectiveness as determined from planned technical-economic indexes, but also of the value of the enterprise to the socialist planned economy.

Proper utilization of the productive capacity of shipbuilding and ship-repair enterprises, based on the broad-scale application of socialist forms of labor organization providing for the uninterrupted growth of productivity, is a guarantee of the fulfillment and overfulfillment of the quantitative and qualitative indexes envisioned by the plans.

25X1

Page Denied

Continuation of Supplement 1

Transfer-operation number	Transfer operation	Tool: Cutting: Name	Tool: Cutting: Size	Tool: Measuring: Name	Tool: Measuring: Size	Part Size: Diameter or width	Part Size: Length	Allowance per side	Machining System: Depth of cut	Machining System: Speed of cut	Machining System: Number of turns	Machining System: Feed	Machining System: Number of passes	Part-Working Time: Mechanical	Part-Working Time: Auxiliary
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Determine size and lift part														0.6
	Cut end (1) clean and polish	VK8 trimmer	25 x 25			360	20	10	5	60	55	0.2	2	1.88	0.4
2	Turn surface (2) to diameter of 352 (-0.3) and [inside] diameter of 320 (20 rings)	VK8 inside cutter	25 x 25	Slide gauge	500	360	320	4	4	60	55	0.3	1	19.5	1.1
3	Drill surface (3) to diameter of 328 (+0.3) and [inside] diameter of 320 (20 rings)	VK8 drill cutter	25 x 25	Pin gauge		328	320	4	4	60	60	0.8	1	18.0	1.0
4	Drill edge 1.8 x 45° to diameter of 328 (+0.3)	VK8 shaper	25 x 25, 45°	Templet	1.8x0.45°	331.1	1.8	1.8	1.8	6.0	6.0	0.3	1	0.1	0.4
5	Cut into surface (3) and drill edge 1.8 x 45°, keeping diameter of 10.6	Same	45°	Same	1.8x0.45°	331.6	1.8	1.8	1.8	6.0	6.0	0.3	1	0.1	0.6
6	Cut off finished product along surface (4), keeping diameter of 10.6 ± 0.1	VK8 cutoff cutter	25 x 25	Slide gauge	125	352	10.2	5	5	50	50	0.06	1	3.3	0.6

Supplement 2

SUMMARY MECHANICAL PROCESSING CHART NO 672-9

Name of Center

Piston in Assembly Drawing No

Name of Part

50 GRS Engine

Part No	Name of Part	No of Part Drawings	Material	Technical Specifications	Type of Work	Amount of Work Per Part	No of Parts: On Machine No	No of Parts: Total	Weight in kg: Crude	Weight in kg: Net	Time Norm in Hrs: Per Part	Time Norm in Hrs: Total	Total Preparatory and finishing time
	Compression Piston Ring	D-65150 607-4	Cast Iron SCh 21-40	Co. Drawing	Casting Diameter 360	360 x 320 x 16		50		0.76	0.417	22.02	1.17

Supplements:
1 Cross-section of part
2 Chart No

No of Operation	Name of Operation	No of operational chart	Equipment: Name	Equipment: Technical Characteristics	Tool: Name	Tool: Dimensions	Tool: Name	Tool: Dimensions	Attachment: Name	Attachment: Drawing No	Worker's Specialty	Labor Category	Time Norm in Hours: Per Part	Total, with Preparatory & Finishing	Total Preparatory and Finishing
5	Turning, drilling and cutting of ring		Lathe	DIP-300	Trimming cutter VK8 Hole cutter VK8 Drilling cutter VK8 Shaped cutter VK8 Cutoff cutter VK8	25x25 25x25 25x25 25x25 45° 25x25	Slide gauge Same Pin gauge Templet 6-4	500 125 1.8 x 45°	4-pronged chuck		Lathe	5	0.2	10.2	0.2
10	Joint miller (5)		Horizontal miller	681	Disc miller of hi-speed steel	Diameter 60	Slide gauge Radius gauge	125 2	Part holder P-51-672-00-0-00		Miller	5	0.052	2.78	0.08
15	Joint angle rounder		Bench		Smooth-cut file	200	Radius gauge	0-2			Fitter	4	0.016	0.85	0.05
20	Control of operations no's 5, 10 and 15		Same				Slide gauge Radius gauge Pin gauge Templet	500 125 2 1.8x45°			Controller	-	-	-	-

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Continuation of Supplement 2

Operation Number	Name of Operation	Operational Chart Number	Equipment: Name	Equipment: Technical Characteristics	Tool: Name	Tool: Size	Tool: Name	Tool: Size	Attachment: Name	Attachment: Drawing No	Workers' Specialty	Work Category	Time Norm, in Hours: Per Part	Time Norm, in Hours: Total, Including Preparatory and Finishing	Time Norm, in Hours: Total Preparatory and Finishing
25	Thermofixation	-	Thermo furnace	-	Thermopair	800°	Mandrel		-		"Thermist"	5	-		
30	Control of thermofixation		Bench		Press		Rockwell tape equipment	125			Controller				
35	Grind ends (1) and (4)	-	Surface Grinder	ZPK	Ceramic abrasive disc, corundum, SM-SM 2, 46 grain-size	0400	Gap micrometer	0.25 + 0.06 10 ÷ 6.08	Magnet table		Grinder	5	0.07	3.66	0.16
40	Drill final surface (3)	-	Lathe	DIP-200	VK6 drill	25x25	Pin gauge		3-pronged chuck with drilled prongs		Turner	5	0.016	1.0	0.2
45	Turn surface (2)	-	Same	DIP-200	VK6 inside cutter	25x25	Micrometer, GOST 20027 Calibration ring	300 0-25 345 diameter	Attachment for 20 units, type PTO-672-00-0-00		Grinder	5	0.027	1.55	0.2
50	Control of operations Nos 35, 40, and 45	-	Bench	-	-	-	Indicator micrometer Probe Pin gauge	0-25 2	Calibration ring Gap attachment 10÷0.06+0.08		Controller	-	-	-	-
55	Drill aperture (6)	-	Drill press NS-12	-	High-speed steel drill	08	Slide gauge	125	Flexible hose-conductor, P 23-672-00--0-00		Driller	4	0.02	1.13	0.13
60	Control of operation No 55	-	Bench	-	-	-	Slide gauge	125	Tape instrument		Controller	-	-	-	-
65	Preservation and packing	-	Bench	-	-	-	Fiber bundle		Apron, gas tank, lard tank		Worker	3	-	-	-

Supplement 3

Cf. summary chart No — TECHNOLOGICAL CHART NO 672-80 L FOR FOUNDRY OPERATIONS — **Operation No**

Name of part	Name of part	Part No
"MAN" 285 x 420 Engine	Cylinder liner. Drawing No D 28/130002	

Technical specifications

Material		Chemical composition, in percent	Mechanical properties				Hydraulic tests	Beam melt test	
GOST	Type		Tensile strength	Bend resistance	Deflection	Hardness	According to tech. specific's.	Size	Number
	SCh-24-44		24	44	8mm	170-229		l = 650 mm Ø = 30 mm	3

Material	No of removable parts	Model No	Outside dimensions of part	Drawing No	Special Attachments	Weight in kg: Assembled Form	Cast Form	Castings with gates	Net castings	Machined part
	None	1	986 max. Ø 367		None	1300	1500	200	145	100

Forming

Name of form part	No of models	Type of form	Lining No	Lining Weight	Weight per shift	Molds Length	Molds Width	Molds Height
Upper	1	Dry		70	200	1400	700	350
Lower	1	Dry		70	200	1400	700	350

Form painting: Paint No	Amount of paint: Pre-drying	Post-drying	Form cutting: Peg size	Distance between pegs	Form drying: Dryer	Temp	Time
	1	1	No pegs		Chamber	350-400°	16 hrs

Gate system

Riser No	Riser Size	Slag remover No	Slag remover Size	Feeder No	Feeder Size
1	Ø 45; l = 220; δ = 13.8	1	Ø 45; l = 15.8 δ = 9.7	6	$\frac{20+10}{2}$ x 10 = 15

Assembly of molds and dimensions of excrescences

Assembly templet	Reinforcing	Cup No	Cup Size	Lip No	Lip Size	Surplus No	Surplus Size	No of Drawing
None	Bolts	1	300 x 300 h = 175		l = 280 h = 150	None		

Supplementary Remarks

Forms are made from split models in double molds. The part is formed horizontally and, when form is dry, both halves of mold are placed together upon 4 bolts.
The two molds, rolled by crane, are rotated 90° and placed under vertical lining. This system takes advantage of horizontal forming and assembly, and of vertical lining.
Slag and debris are removed twice: initially in the gate cup under the cast-iron flow starter, and later in the slag-remover ring.
Cores are made of two halves glued with sulfite glue or beluga and connected by wire to cast-iron rack. Cores are placed in the lower half of the form on bands. Between form and core, on the facing, are fissures, which are filled in with earth.
In casting, 0.3-0.4% ferrosilicon (75%) should be placed in the trough such that the final silicon content of the metal will be 1.5-1.7%.

Continuation of Supplement 3

Preparation of Cores

Cores	No of Cores	Box Material	No of Molds	No of Core Mixture	Method of Ventilating Cores	Body Material	Body Size	Method of Combining Cores	Pattern for Checking	Paint Pre-Drying	No Post-Drying	Dryer Type	Drying Temp	Drying Time
1	1	Wood	48		Notches and heat holes in each half of core	Cast iron with wire	22x22 mm	Body tied with wire	None			Chamber	350-400°	16 hrs

Lining

Temp of iron in trough	Pouring Temp	Ladle Capacity	Duration of Pouring	Duration of Hardening
1400-1410°	1380°	350-400 t	30 sec	8 hrs

Trimming Method	Trimming Equipment and Tool	Cleaning Method	Cleaning Equipment and Tool
Manual	Chisel, hammer	Manual	Breaker, scraper brush
Pneumatic	Cutting hammer from "Pnevmatika" Plant		Sand-blasting chamber

Heat treatment -- annealing

Change in technological process

Supplementary Remarks

Specialty	Category	Time	Specialty	Category	Time
Form-maker	5	2 hrs, 20 min			
Core-maker	5	2 hrs, 10 min			
Trimmer	5	0 hrs, 40 min			

No of parts per part	No of parts total	Time norm, in hours per part	Time norm, in hours total	per installation

Compiled by	Checked by	Approved by	Date	OTK	Date

Supplement 4

CAPITAL REPAIR OF AN INCLINED 300-HORSEPOWER STEAM ENGINE

Number	Nature of work (list of operations)	Basic part dimensions, in millimeters	Number of parts	Labor content of machine-tool work in man-hours, and labor category: Marking off	Lathe work	Drilling	Turn-drilling work	Plane work	Shaper work	Grooving	Boring	Milling	Grinding	Turret-lathe work	Bolt-cutting	In the mechanical section*	In the repair-and-installation section	Secondary manpower	Ship machine crews*	Calendar time	Reduced time	Type and quantity of materials required
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	Parts of the Piston Group																					
1	Take apart pistons	D_1 390 D_2 550 D_3 890	3	–	–	–	–	–	–	–	–	–	–	–	–	IV-8	–	II-8	–	8	16	Kerosene, 3 kg; Cleaning waste, 2 kg
2	Instead of replacing, build up surface of worn steel piston	D-390	1	–	–	–	–	–	–	–	–	–	–	–	–	Electric welder V-6	–	II-1	–	7	7	Electrodes, 6 kg
	(a) Turning and drilling piston	D-390	1	–	No-9 V-5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	5	–
	(b) Scouring grooves and rings	D-390	2	–	–	–	–	–	–	–	–	–	–	–	–	V-24	–	–	–	24	24	–
	(c) Preparing piston rings (casting, turning, cleaning)	D-390	2	IV-1	No-6 V-7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8	8	Cast iron, 15 kg
	(d) Assembling piston	D-390	2	–	–	–	–	–	–	–	–	–	–	–	–	V-3	–	–	–	3	3	–
3	Check piston-ring grooves on machine	D-550 D-890	2	–	–	–	No-32 VI-6	–	–	–	–	–	–	–	–	–	–	–	–	6	6	–
4	Polish piston-ring grooves	D-550 D-890	2	–	–	–	–	–	–	–	–	–	–	–	–	VI-8 IV-8	–	–	–	8	16	–

* Columns 17 through 20: Labor content of manual work, in man-hours, and labor category

Continuation of Supplement 4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
5	Finish and fit piston rings and fit scarves (casting, turning, polishing, planing, and fitting scarves)	D_2-550	2	IV-1	-	-	No 32	-	-	-	-	-	-	-	-	VI-40	-	-	-	-	-	Cast iron, 50 kg
		D_3-890	2	IV-1	-	-	VI-24	-	No 41 III-7	-	-	-	-	-	-	IV-40	-	-	-	72	113	
6	Replace clamp springs of piston rings	Wire diameter 3 mm, Spring diameter 50 mm	12	-	-	-	-	-	-	-	-	-	-	-	-	IV-12	-	-	-	12	12	Steel wire, 3 kg
7	Replace reinforcing pins and bolts of piston caps	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	(a) Drilling out old ones	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	III-5	-	-	5	5	-
	(b) Straightening aperture threads	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	III-3	-	-	3	3	-
	(c) Turning and cutting of pins	-	-	-	-	-	-	-	-	-	-	-	-	No 70 III-7	-	-	-	-	-	-	7	Rod steel, 8 kg
	(d) Installation	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	III-4	-	-	4	4	-
8	Assemble pistons	-	3	-	-	-	-	-	-	-	-	-	-	-	-	V-6	-	V-6	-	6	12	Kerosene, 1 kg; Cleaning waste, 1 kg
9	Instead of replacing, build up worn surface of piston rod	-	1	-	-	-	-	-	-	-	-	-	-	-	-	Electric welder II-14	-	II-1	-	15	15	Electrodes 22 kg
	(a) Turning	-	-	-	No 7 V-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	5	-
	(b) Grinding	-	-	-	No 67 V-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-
	(c) Producing nuts: (chamfering, cutting threads, milling edges)	Diameter 50	2	IV-1	No 1 IV-6	-	-	-	-	-	-	III-62 III-3	-	-	-	-	-	-	-	9	9	Steel forgings, 10 kg

Continuation of Supplement 4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
10	Check on machine, turn, and cut off piston rods	1 = 1600	-	-	No-7 V-10 No-67 V-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10 4 -	10 4 -	- -
11	Seal runners with white metal	150x100	6	IV-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	-
	(a) Sealing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	White metal, 20 kg
	(b) Shaping	-	-	-	-	-	-	-	No-41 IV-9	-	-	-	-	-	-	-	-	-	-	9	9	
	(c) Scouring and parallel fitting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	VI-16 IV-16	-	-	-	16	32	-
	(d) Trimming, with alignment of leeway	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	VI-6 IV-6	-	-	6	12	Cleaning waste, 0.5 kg
11a	Replace reinforcing bolts of runners	Diameter 12	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Steel rod 5 kg
	(a) Turning and threading of bolts	-	-	-	-	-	-	-	-	-	-	-	-	No 70 III-4	-	-	-	-	-	4	4	-
	(b) Milling heads	-	-	-	-	-	-	-	-	-	-	No 62 III-2	-	-	-	-	-	-	-	2	2	-
12	Turn and polish wrist-pin necks	Diameter 80 1 = 350	3	-	No-9 IV-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	8	-
13	Instead of replacing, gas-heat surfaces of bronze liners of head bearings	Diameter 80	2	-	-	-	-	-	-	-	-	-	-	-	-	Gas-welder IV-3	-	-	-	3	3	Brass wire, 3 kg
	(a) Turning	-	-	-	No-3 IV-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	-
	(b) Fitting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	V-8	-	II-4	-	8	12	-
14	Instead of sealing, gas-heat surfaces of bronze liners of head bearings	Diameter 80	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	(b) Turning	-	-	-	No 3 IV-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	6	-
	(c) Cutting out lubricating channels, scouring, and fitting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	V-8 IV-8	-	V-6	-	8	22	Cleaning waste, 0.5 kg
15	Seal liners of crank bearings	Diameter 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	(a) Sealing	Diameter 200	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	White metal, 50 kg
	(b) Marking off	-	-	IV-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	-
	(c) Turning	-	-	-	-	No 24 V-6	-	-	-	-	-	-	-	-	-	-	-	-	-	6	6	-
	(d) Packing metal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	III-6	-	-	-	6	6	-
	(e) Final turning	-	-	-	-	No-24 V-41	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	4.5	-
	(f) Cutting out lubrication channels, scouring, and fitting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	V-8 IV-8	-	II-6	-	8	22	Cleaning waste 0.5 kg
16	Replace tension bolts with nuts in crank connections	1 = 350 Diameter 60	2	III-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Steel forgings, 20 kg
	(a) Forging	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	(b) Turning and cutting	1 = 350 Diameter 60	2	-	No 2 IV-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	16	-
	(c) Drilling	-	-	-	-	-	-	-	-	-	No-53 III-2	-	-	-	-	-	-	-	-	2	2	-
	(d) Milling edges	-	-	-	-	-	-	-	-	-	-	No 62 III-6	-	-	-	-	-	-	-	6	6	-
17	Prepare packing for head and crank bearings (cutting and drilling)	-	9 complete	-	-	-	-	-	-	-	No 53 III-4	-	-	-	-	-	III-9	-	-	13	13	Brass, 3 kg
18	Check connecting rods with piston rods	-	3	V-3	-	-	-	-	-	-	-	-	-	-	-	VI-12 IV-12	-	11-12	-	15	39	-

Note: The tool numbers shown are according to standard dimensions.

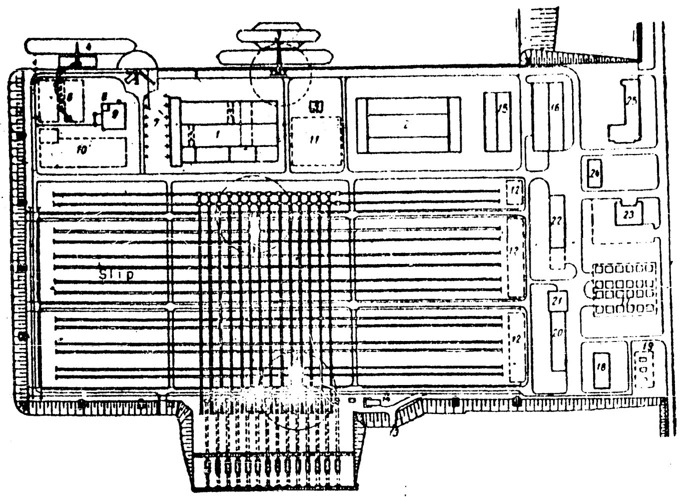

Figure 10. General plan of a ship-repair installation on a peninsula. 1, section block: mechanical, electrical-repair, mechanical-repair, and tool; 2, section block: hull- and boiler, pipeline, electroplating, forge, transformer substation, and compressor station; 3, mooring line for finishing work; 4, floating crane; 5, oxygen station; 6, coal warehouse; 7, steel warehouse; 8, pumping station; 9, boiler room; 10, 11, 12, outdoor work areas; 13, pierce furnace; 14, control panel and transformer substation; 15, woodworking section; 16, central warehouse; 17, warehouse for green lumber; 18, warehouse for dry lumber; 19, warehouse for liquid fuel; 20, garage; 21, electric-truck depot; 22, naval-stores warehouse; 23, firefighting station; 24, passage; 25, installation administration and dining hall.

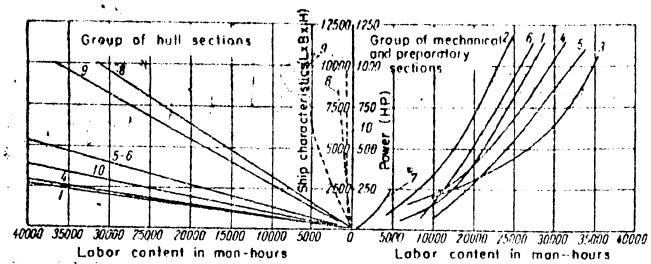

Figure 11. Graph of total labor content in the capital repair of river ships. 1, cargo-passenger steamships; 2, steam tugs; 3, screw-type cargo-passenger Diesel ships; 4, paddle-wheel Diesel tugs; 5, earth-pumping scows; 6, earth-removing scows; 7, motor cutters; 8, dry-cargo wooden barges; 9, oil barges; 10, dry-cargo metal barges.

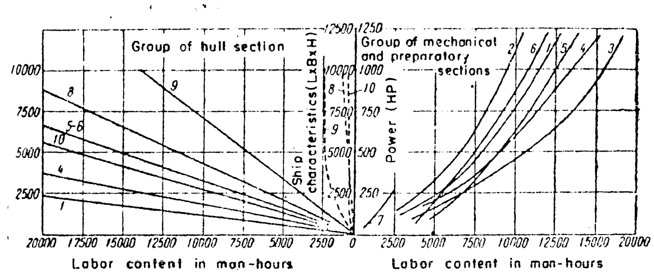

Figure 12. Graph of total labor content in medium repair of river ships

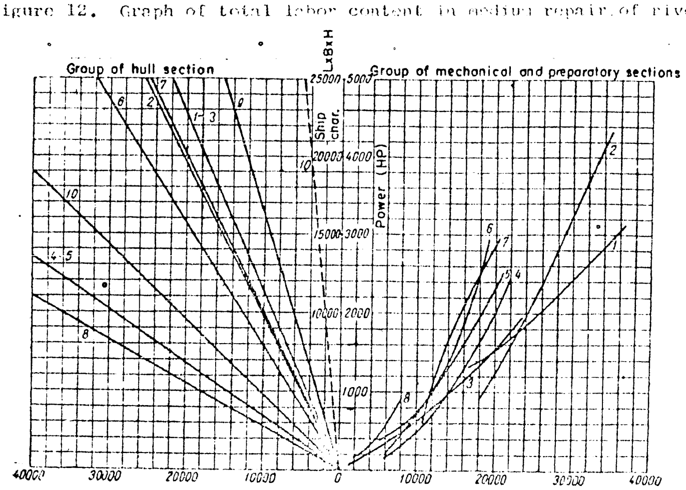

Figure 13. Graph of total labor content in the [illegible] repair of

maritime transport ships. 1, cargo Diesel ships; 2, cargo-passenger Diesel ships; 3, industrial and service-auxiliary ships; 4, earth-pumping scows; 5, earth-removing scows; 6, cargo-passenger steamships; 7, cargo steamships; 8, tugs; 9, oil-tank Diesel ships; 10, dry-cargo barges.

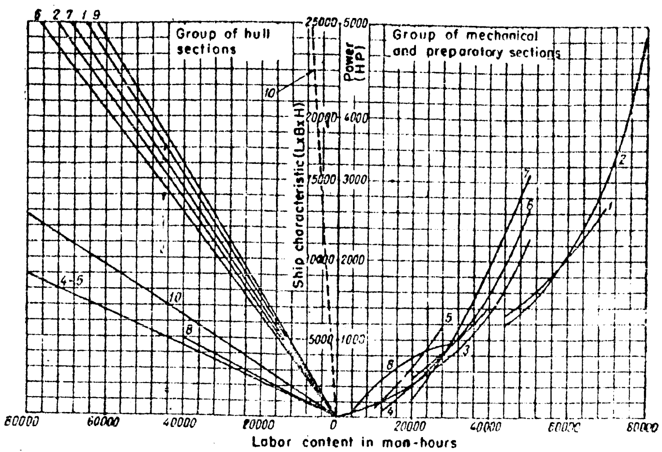

Figure 14. Graph of total labor content of capital repair on maritime transport ships.

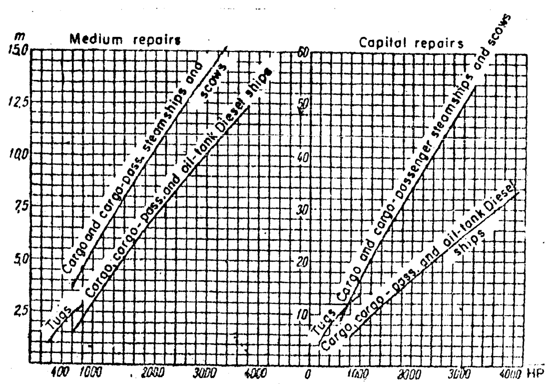

Figure 15. Graph of materials consumption in pipeline section in repairing maritime ships (as a function of capacity of principal machinery).

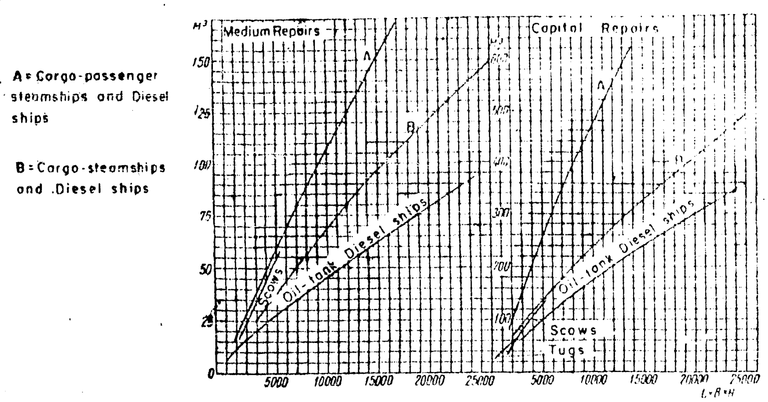

Figure 16. Graph of materials consumption in a woodworking section in repairing maritime ships (as a function of L x B x H).

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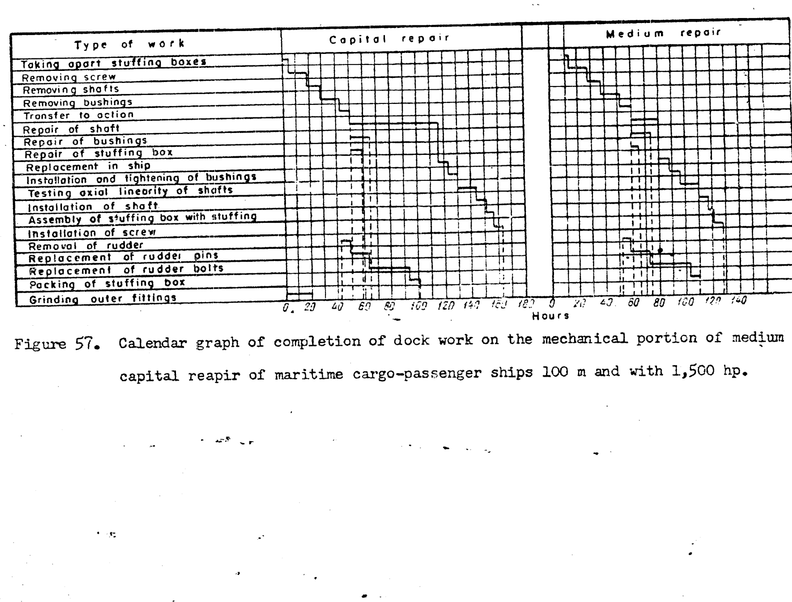

Figure 57. Calendar graph of completion of dock work on the mechanical portion of medium and capital reapir of maritime cargo-passenger ships 100 m and with 1,500 hp.

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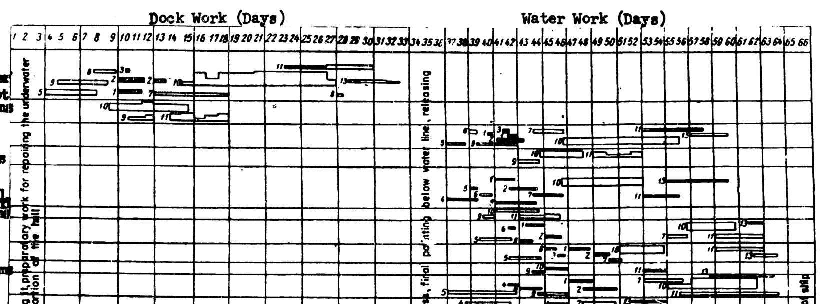
No	Type of work	Number of work days
1	External sheathing	
	Replacement of sheet on underwater portion and straightening on the spot	
	Rep. of rivets and caulking of seams	
2	Waterline work	
	Rep. of sheet	
	Rep. of rivets and caulking of seams	
3	Deckline and false deckline above waterline placement	
	Rep. of sheet, repair and removal of angle irons and stanchions, and rep. of decking/ Rep. rvt. cak. seams	
4	Upper deck	
	Rep. of sheet	
	Rep. of some fittings	
	Rep. of rivets and caulking of seams	
5	Flooring of superstructure	
	Rep. of sheet	
	Rep. of some fittings	
	Rep. of rivets and caulking of seams	
6	Flooring of second bottom	
	Rep. of sheet	
	Rep. of stringer sheet	
	Rep. of some fittings	
	Rep. of rivets and caulking of seams	
7	Fittings in neighborhood of pinnacles	
	Rep. of some fittings	
8	Fittings in neighborhood of machine dep.	
	Rep. of some fittings	
9	Hold fittings	
	Rep. of some fittings	
	Straightening of ribs on the spot	



POOR ORIGINAL

10 Bulkheads
   Rep. of sheet
   Rep. of stanchions and angle irons
   Rep. of rivets and caulking of seams
11 Coal chute
   Rep. of sheet
   Rep. of fittings
12 Chain box
   Rep. of sheet
   Rep. of fittings
13 Propeller-shaft tunnel, with recess
   Rep. of sheet
   Rep. of fittings
14 Foundations of machinery and boilers
   Rep. of sheet
   Rep. of angle irons
   Rep. of rivets
15 Internal bracing
   Rep. of sheet
   Rep. of angle irons
   Rep. of rivets
16 Cargo-hatch coamings
   Rep. of coaming angle irons
   Caulking of coaming angle irons

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Legend

Shop work:
1 Marking out
2 Machining
3 Hot working

Outside work:
4 Cutting rivets
5 Heating rivets
6 Planning parts
7 Installing parts
8 Straightening on the spot
9 Boring and drilling
10 Riveting
11 Cutting and caulking
12 Autogenous cutting
13 Electric welding

Figure 58. Calendar graph of the capital repair of the metal hull of a maritime cargo ship of 3,000 tons' capacity.

POOR ORIGINAL

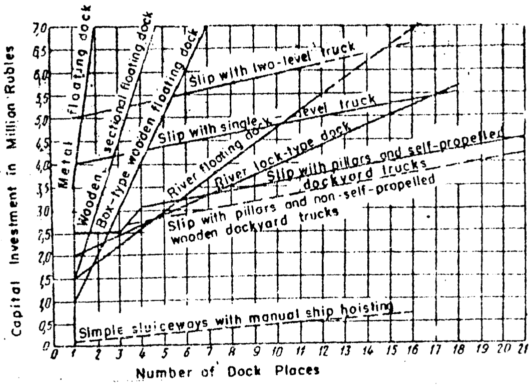

Figure 59. Diagram of primary capital investment per dock-place as a function of the type of ship-hoisting structure and the number of dock-places.

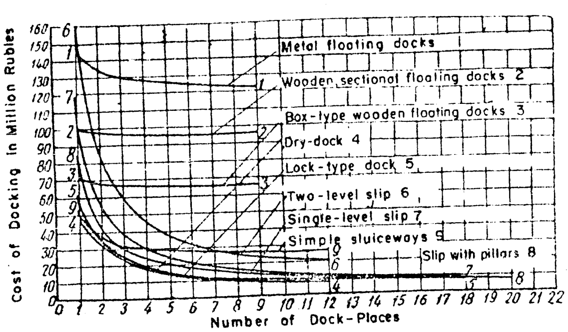

Figure 60. Diagram of the cost of docking as a function of the type of ship-hoisting structure and the number of dock-places.

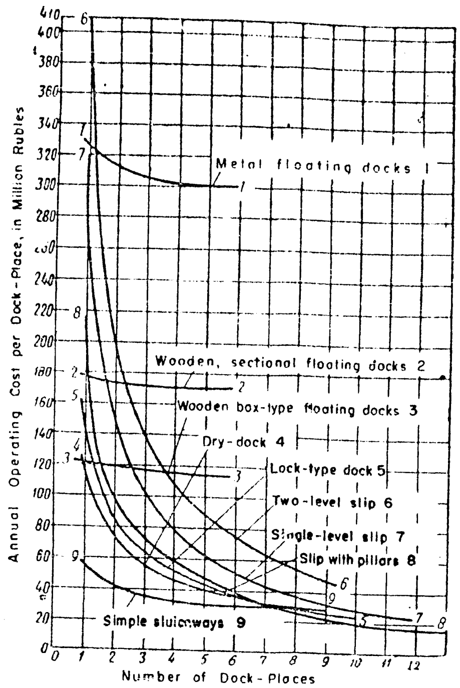

Figure 61. Diagram of the cost of operating ship-hoisting structures as a function of the number of dock places.

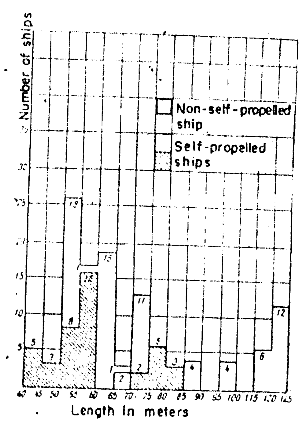

Figure 62. Diagram of breakdown of ships by length (for ships over 40 m long).

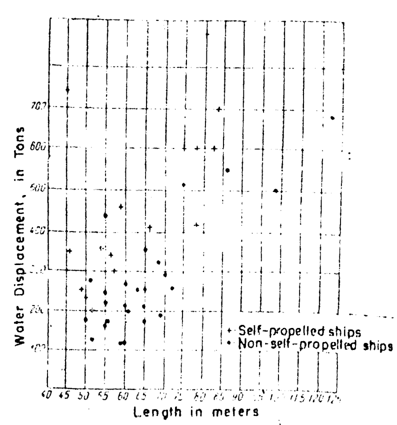

Figure 63. Diagram of the water displacement of ships as a function of their length (for ships over 40 m long).